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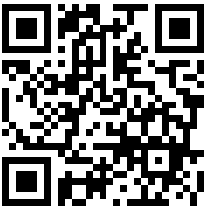

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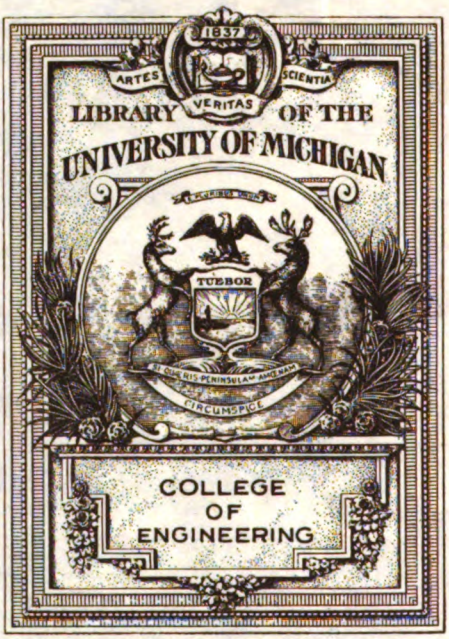

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Popular Radio

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25¢

JANUARY, 1924

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MAY 25 1927

Popular Radio

Edited by KENDALL BANNING

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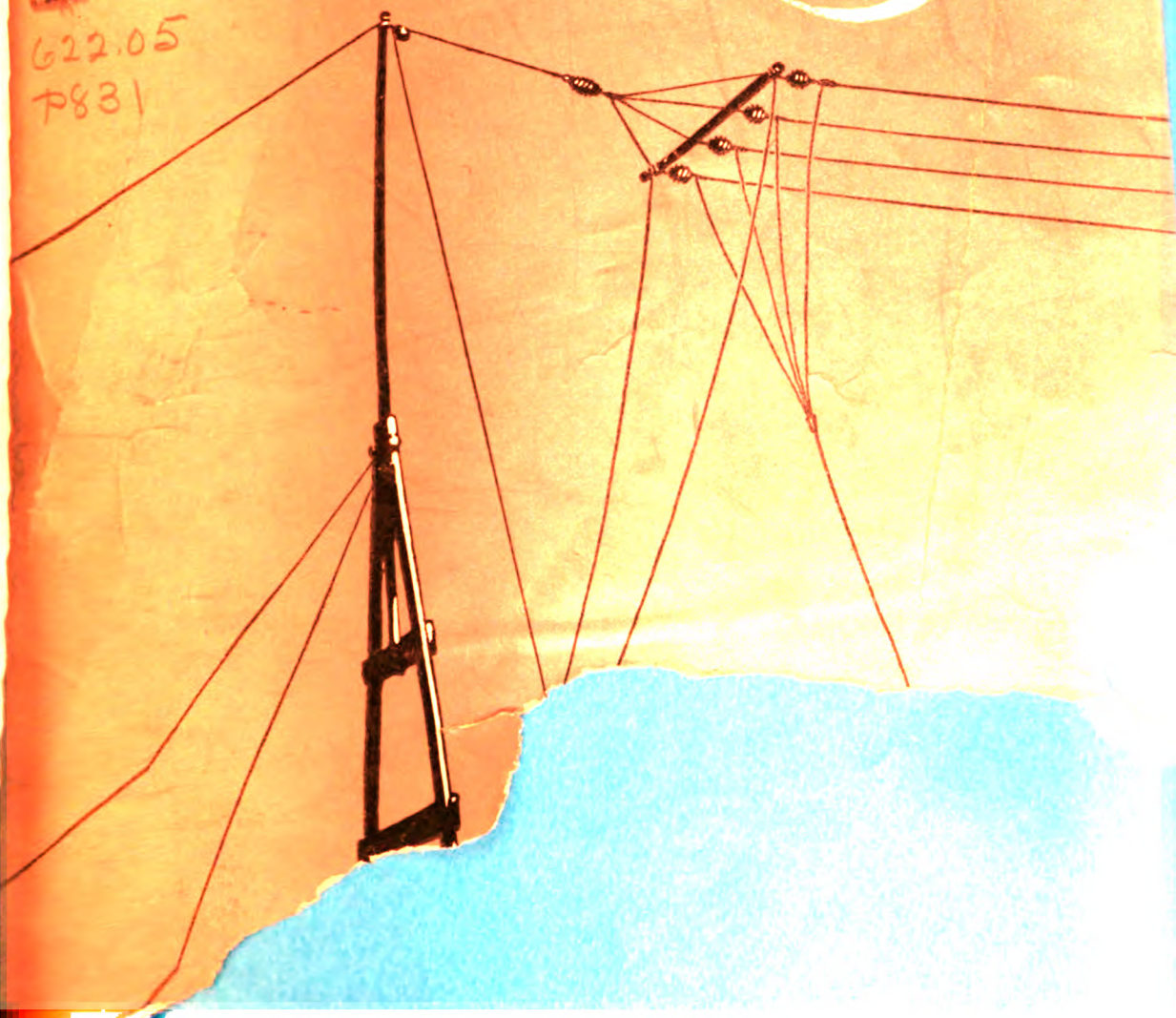

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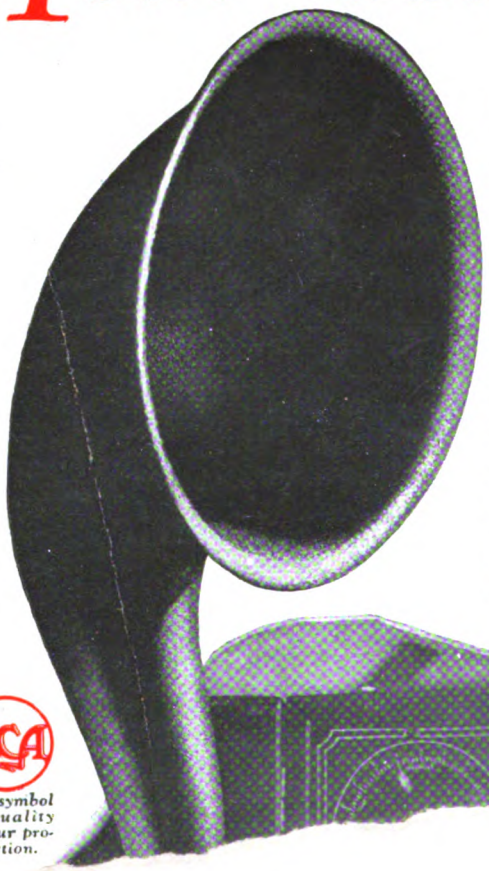
Clear as Your Headphones



CALL in the crowd, now. Everyone can listen in with as much joy as one man at the headphones. Here is a loud-speaker with a reproducing range so wide that it gets all the tones—the high notes—and the low ones—with all their overtones and partials—full and rich. With a horn so perfect that it causes no distortion—adds no vibration of its own. And a one-finger adjustment that controls the volume, at your pleasure. Everything—music, speech, sports news—*clear for the crowd!* No more one-man radio sets. Everybody gets it—all!

Radiola Loudspeaker
Model U. Z.—1320
Price $36.50

RCA

This symbol of quality is your protection.

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3 Broadway, New York
Ill. 433 California St., San Francisco, Cal.

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Brandes

Table-Talker

TRADE MARK REG. U.S. PAT. OFF.

Everybody-listen in!

"Tune" with your *Matched Tone* Headset. Then let the family listen with a Brandes *Table-Talker!* The perfect combination for *real* radio fun.

The new *Table-Talker* does for group-listening what the *Matched Tone* Headset does for the individual.

It provides true tone—mellow and strong. It reproduces the program faithfully—from the deepest speaking voice to the highest instrumental music. And it's a good-looking addition to any set—with its simple lines and neutral brown finish. A *remarkable* loud-speaker!

$10

50c additional west of the Rockies

All Brandes Products are sold under a money-back guarantee.

C. BRANDES, Inc., New York

Matched Tone

TRADE MARK REG. U.S. PAT. OFF.

Radio Headsets

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(Cover design by Frank B. Masters)

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"Live in harmony with your age."
Lao Tzu

To be in harmony with the present age, you must own a

GREBE

BROADCAST RECEIVER

Doctor My.

GREBE RADIO

THE 20-foot silk-covered wire, supplied with this Receiver, is the only antenna required. This wire may be concealed behind the picture moulding or run along the baseboard in your library or living room.

The beautiful walnut cabinet has compartments for all necessary batteries.

Write for "Grebe Radio in the Well-Appointed Home"

A. H. GREBE & COMPANY, Inc.
Richmond Hill, N.Y.
Western Branch, 451 East 3rd St., Los Angeles, Cal.

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PAGES WITH THE EDITOR

BEGINNING with this number the regular publication date of POPULAR RADIO is the 20th of each month preceding the date of publication.

* * *

WHEN POPULAR RADIO inaugurated the policy of mentioning specifically by name the exact parts that are required for the most successful operation of the circuits described in its pages, it did so with just one purpose in view: *to help the experimenter build and use his set to the best possible advantage.*

* * *

THE Editor was fully aware of the dangers that lurked in such a policy—a policy that was unique in the radio field where the editorial methods of the trade journal and of the house organ so largely prevail.

* * *

IN the first place, several manufacturers of radio apparatus (and some of the more skeptical of our readers as well) assumed that editorial mention of these parts was inspired by our advertisers.

This was not, is not and will not be the case.

Such radio parts as are mentioned in our reading pages are specified by our technical staff as the result of long and careful experimentation in the laboratory, and these parts are recommended for use *only for the specific set that is under consideration.*

* * *

No pressure from the business office has influenced, nor will it influence, the unbiased judgment of our technical staff.

* * *

THE Editor believes that our readers are entitled to the most helpful, practical, specific and authoritative data that our staff can give them. And he believes that the mention by name of such parts as are necessary to the most successful operation of their sets is not only exceedingly valuable but, in fact, essential.

* * *

APPARENTLY this policy is receiving the substantial endorsement of the great army of radio fans — if the remarkable growth of POPULAR RADIO in circulation is any criterion. Apparently, too, our readers are quick to express their approval in personal letters. Out of the mail bag the Editor picks at random the following endorsement that comes from Fort A. A. Humphreys, in Virginia:

* * *

"I AM sorry that any question of business ethics has come up in the matter of your publishing the name of the parts necessary to make a working receiver. It is knowledge. It is what I have been craving since the hook-ups have first been published. For the average tinkerers with radio to go into a large store to pick out parts is nothing but a gamble pure and simple. There are, say, twenty different kinds of each and every part he may desire, and it takes no mathematician to figure the number of permutations and combinations he may form or the chance he has of picking out the right combination. Here is one reader who most heartily endorses your policy. Personally, I have ordered the parts for the tuner and oscillator through my Washington dealer, and if there is any violation of business ethics in that, then let us change our ethical viewpoint."

—GEORGE A. BROWN

* * *

EVEN from abroad come letters that endorse this policy. From an engineer in Nancy, France, for instance, comes this word of approval:

* * *

"I appreciate very much the fact that when describing new sets you give all the data and the names of the furnishers of spare parts. This is very useful, especially for foreigners who have no connections with the dealers of your country."

—EMILE F. LANORD

* * *

AGAIN POPULAR RADIO has had another feather stuck in its editorial cap! The first prize awarded to amateur sets at the New York radio show in October fell to Oliver B. Parker of Brooklyn, N. Y., whose receiver was unanimously proclaimed the best for "originality, craftmanship, workability and all-around excellence." And the set was a Cockaday four-circuit tuner—the set that was first announced in POPULAR RADIO for May, 1923—arranged in a portable cabinet that included an aerial. This clever adaptation of the famous Cockaday circuit will be described in this magazine by Mr. Parker himself.

* * *

THE four-circuit tuner—popularly known as the "Cockaday Circuit" in honor of the inventor, who is the Technical Editor of POPULAR RADIO—is hitting the middle west with a bang. Reports indicate that the fans of the district between Buffalo and Kansas are beginning to get acquainted with this new and wonderfully efficient receiver.

* * *

ONE fan out in Chicago, H. W. Bond, for instance, wrote recently to a friend in Memphis, Tennessee:

"Tell the boys that if they want a real receiver that *tunes*, to junk their standards, reflexes and singles and build a Cockaday four-circuit, stick in two new-type, low-ratio Thordarsons and lean back and listen to everything from Hell, Hull and Byhalia. It is the only medium priced receiver that, from Chicago, will tune out WDAP and KYW and pick up outside stations so that they can be put on the loudspeaker."

* * *

IT is estimated that about 500,000 radio fans in this country alone have built the Cockaday

(*Continued on page* 6)

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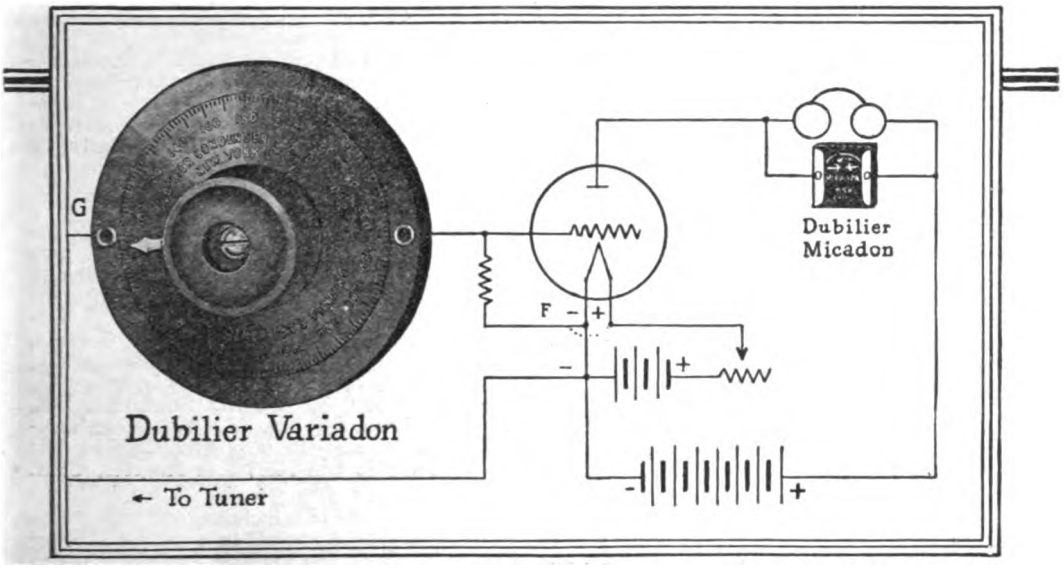
AT F, the filament terminal of the grid leak is shown connected to the negative side of the tube. Occasionally better results are obtained by connecting the grid leak terminal to the positive side of the tube.



The Variadon—*a Variable Grid Control*

BETTER than the average variable grid-leak and a fixed condenser in a grid-circuit are the Variadon (the Dubilier variable mica condenser) and a fixed resistance.

Better because it is difficult to control the resistance with the average variable grid-leak *but certain and easy to control the capacity* of the grid-circuit with the Dubilier Variadon.

Used with a fixed resistance the Dubilier Variadon greatly increases both the selectivity of the set and the volume of the signals. Thus disappear the difficulties experienced when poor variable grid-leaks are used.

Because of its compactness the Dublier Variadon readily finds a place in the average cabinet. It is no larger than an ordinary dial.

Price $2.50. At all good dealers.

Write for further information to department 125.

DUBILIER CONDENSER & RADIO CORPORATION
48-50 West Fourth Street
New York

DUBILIER DUCON
The Standard Socket Plug

DUBILIER MICADON
The Standard Fixed Condenser

DUBILIER DURATRAN
Radio-Frequency Transformer

DUBILIER DEVICES

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(*Continued from page 4*)

four-circuit tuner. And now the Editor is beginning to get reports about its steadily growing popularity in England, Europe and South America.

* * *

TYPICAL of the hundreds of letters that have reached the Editor from enthusiastic fans, is the following from Douglas Henderson of New York; he writes:

"Since 1922, when radio broke out in good shape, I had used the conventional regenerative tuner with a variometer in the plate circuit; the results were satisfactory. But—about the 15th of last May when the wavelengths changed according to the new government regulations, I moved from the Bronx out to Richmond Hill. The former location was such that I had a small outdoor aerial but out where I am now it is out of the question. Hence I resorted to an indoor arrangement whereby a small wire was run around the rooms, concealed. The moving and change of wavelengths was too much for the old set and talk about interference . . . . WOW!

* * *

"THEN came POPULAR RADIO with your new circuit and I was just in the right frame of mind to put it into effect. The results were immediate. With that little farce of an antenna, using WD-11 tubes throughout with 45 volts on the plate, I have been literally astounded at the stations I hear. The aerial violates every known rule, being a piece of single cotton-covered magnet wire salvaged from an old variometer; in many places the insulation has been destroyed, and is tacked around the baseboard of the rooms with ordinary carpet tacks, without insulation. The far end terminates on a bedspring.

"Everything as far west as Chicago arrives in a satisfactory manner."

* * *

AGAIN the Editor feels constrained to utter a friendly word of warning to our readers against manufacturers of and dealers in "outlaw" radio apparatus that is made by radio bootleggers in violation of patent rights. And also against apparatus that is unsound scientifically or cheaply made or otherwise inefficient and unsuitable for use. And against unscrupulous promotors who aim to sell stock in such enterprises.

* * *

SOME of these promotors have issued advertising circulars that quote from articles that have appeared in POPULAR RADIO, and quoted them in a way that might be construed as indicative of this magazine's endorsement. These quotations have been made without the Editor's knowledge or approval. In order to counteract the impression that these quotations may create, the Editor *especially* warns our readers against those stock dealers who quote POPULAR RADIO in their advertising circulars.

THE success of the Haynes DX receiver—described in our September number—was instant and nation-wide. One fan out in Winfield, Kansas, has written in such an interesting report of it that the Editor is sharing it with our readers.

Here it is:

* * *

"I built the Haynes DX receiver as described in POPULAR RADIO and added two stages of audio amplification. In one evening I heard the following stations, all on a loudspeaker: WHAS Louisville, Ky., WOS Jefferson City, Mo., WSB Atlanta, Georgia, WOC Davenport, Iowa, WJAZ Chicago, Ill., KYW Chicago, Ill., WDAP Chicago, Ill., WOAF Omaha, Neb., KSD St. Louis, Mo., WGY Schenectady, N. Y., WLAG Minneapolis, Minn., and the next evening KFI Los Angeles, Calif., and KHJ Los Angeles, Calif.

* * *

"THE complete set (including the two stages of audio amplification) is in a cabinet 10½ by 7½ by 6 inches, the variable condenser which is in the grid circuit is a .0005 with vernier, a .00025 which I first used worked fine but it would not allow me to tune above 411 meters; the fixed condenser across the primary of the first audio transformer is a .0005; a .002 worked but the .0005 was much better; this I believe is due to the transformer which is an All American ratio 10-1.

* * *

"THIS set is a real DX receiver, the tuning would probably be difficult with rough tuning devices but I considered this in selecting the parts, which are a Bradleystat for the detector, an A. C. Hayden sharp-tuner dial for the tickler and the .0005 variable condenser with vernier for the grid circuit."

—BERT DECK

* * *

SPECULATION about "the receiving set of the future" is beginning to focus upon a type that is aptly referred to, in an Esteemed Contemporary, as follows:

"To do away with the tinkering—simply to turn one handle to a definite, marked point and get the station wanted, if it is transmitting; that is the kind of set which will probably find a good deal of favor in the future."

The prophecy is signed "J. H. M.," whom the Editor suspects is no other than the eminent physicist, Prof. J. H. Morecroft. It is with particular gratification, therefore, that the Editor is able to refer our readers to a detailed description of just such a set—beginning on page 23 of this issue of POPULAR RADIO!

Kendall Banning

Editor, POPULAR RADIO

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The World's Most Popular Battery Charger

Nothing speaks so eloquently of HOMCHARGER satisfaction as the fact that thru sheer merit alone it has become the *standard* by which all other battery chargers are judged. Over 125,000 HOMCHARGERS already in use offer the most convincing proof that it is the most efficient, economical and fool-proof battery charger at any price.

A NEW TRADE-MARK FOR A TRIED AND PROVEN PRODUCT

Its phenomenal success has led to the introduction of many inferior and make-shift imitations. To insure our reputation and protect the buying public against substitution, the Radio De Luxe HOMCHARGER henceforth will be sold under a new Trade-Mark, viz:

GOLD SEAL HOMCHARGER

Retaining the same fundamentally correct operating principle and beautiful appearance of our Radio De Luxe model, it is a step nearer ultimate perfection through adoption of several construction refinements dictated by the policy of Progress.

HOMCHARGER'S 10 POINTS OF SUPERIORITY

1. **Simple**—Only one moving and wearing part, replaceable after thousands of hours use for $1.00. Will last a lifetime.
2. **Efficient**—Uses less than one-half the current of any bulb or liquid type rectifier. Will charge any radio or automobile battery for a nickel.
3. **Quick**—Its high charging rate of 7 amperes eliminates long waiting for battery to become charged. Will charge any "A" or "B" battery over night, or three times as fast as a 2-ampere machine.
4. **Clean**—No expensive bulbs to break or acids to spill or replace. No acid fumes. Charges without muss fuss or bother.
5. **Dependable**—Tungsten contacts insure continuous operation—prevent sticking and stopping.
6. **Fool-Proof**—Can be operated by anyone. Attach to lamp socket and connect battery either way, it will always charge. High-grade ammeter eliminates guess work.
7. **Safe**—No danger of shock or fire. Tested and approved by Fire Insurance Underwriters everywhere. Gives tapering charge—will not overheat or injure battery.
8. **Beautiful**—Mahogany and Gold Finish
9. **Unqualifiedly Guaranteed.**
10. **Popularly Priced**—Retails at $18.50 complete ($25.00 Canada). No extras to buy. Sold by all dealers.

FREE BROADCASTING LIST. Send to-day for Free List of Broadcasting Stations, and Circular Describing the Gold Seal Homcharger.

DEALERS! JOBBERS!

GOLD SEAL HOMCHARGERS will outsell any other radio device this season. "GOLD SEAL Business Builders" illustrates many attractive sales helps and explains how we are prepared to co-operate with the Trade in making this a "HOMCHARGER Year." Send for your copy and Trade Discounts TODAY.

Insist on the GOLD SEAL

LOOK FOR IT

It is your protection against substitution. When buying *order* by *name* and *verify by the GOLD SEAL*, which appears on the carton as well as the nameplate.

GENUINE GOLD SEAL HOMCHARGER REG. UNQUALIFIEDLY GUARANTEED

The Automatic Electrical Devices Co., 132 West Third St., Cincinnati, O.

Largest Manufacturers of Vibrating Rectifiers in the World

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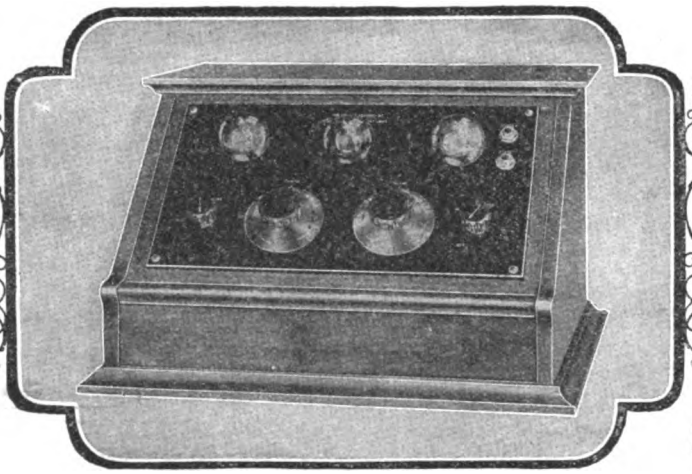

MODEL V

$125.
fully equipped

A New and Radical Radio Achievement

This new Kennedy Model V is one of the foremost contributions ever made to the radio art. It was developed by the Kennedy Engineering Staff to meet a definite demand for a receiver with greatly simplified control—but with the same high standards of selectivity and mechanical excellence that have always distinguished Kennedy radio equipment.

The most striking individual feature of this new Kennedy Model V is its utter simplicity of operation. After a single initial setting is made, only one dial is used to control all tuning. And with this simplicity of tuning comes the positive assurance that, night after night, a given station will "come in" at its own particular setting—*even though the receiver is tuned on different antennae.*

Model V is very selective. For instance, in New York one of these receivers located in the Belmont Hotel "tuned out" station WEAF, only two blocks away, and "brought in" out-of-town stations. It is stable in operation, reproduces music and voice with unusual fidelity and is credited with remarkable distance records. "Re-radiation" is practically eliminated. Responds to all broadcast wave-lengths—operates on any ordinary antenna, outside type preferred.

The cabinet is built of mahogany and follows dignified, harmonious lines that give it a pleasing appearance and make it an attractive addition to any home. The arrangement of the panel is the result of considerable study—it is placed at a height and angle that are new and provide an unusual degree of ease, comfort and precision in tuning. Dials, knobs and tubes are symmetrically arranged and tend to enhance the already attractive appearance of the receiver as a whole.

Model V is an entirely new development in radio science—it is unusually simple to operate, very selective, has high electrical efficiency, presents a pleasing appearance and sells for only $125.00, completely equipped with all tubes, dry batteries, Kennedy 3,000-ohm phones, with plug. This unquestionably stamps it as the one striking value in the radio field.

Ask your dealer to show you the new Kennedy Radio Model V—or write us direct for fully illustrated literature. Other Kennedy models in period furniture designs range up to $825.00 fully equipped, including built-in loud speaker.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS **SAN FRANCISCO**

All Kennedy receiving sets are regenerative.
Licensed under Armstrong U. S. Patent No. 1,113,149

KENNEDY

The Royalty K *of Radio*

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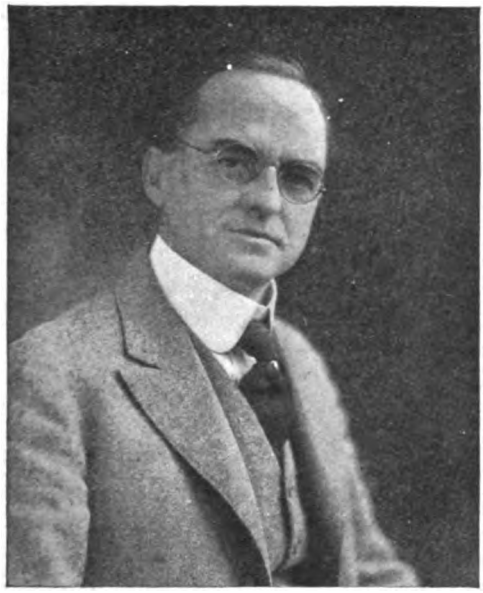

Is Radio Changing Our Mental Habits?

Dr. Willis R. Whitney, one of the world's foremost scientists, thinks it is; he will tell his reasons in a coming issue of POPULAR RADIO.

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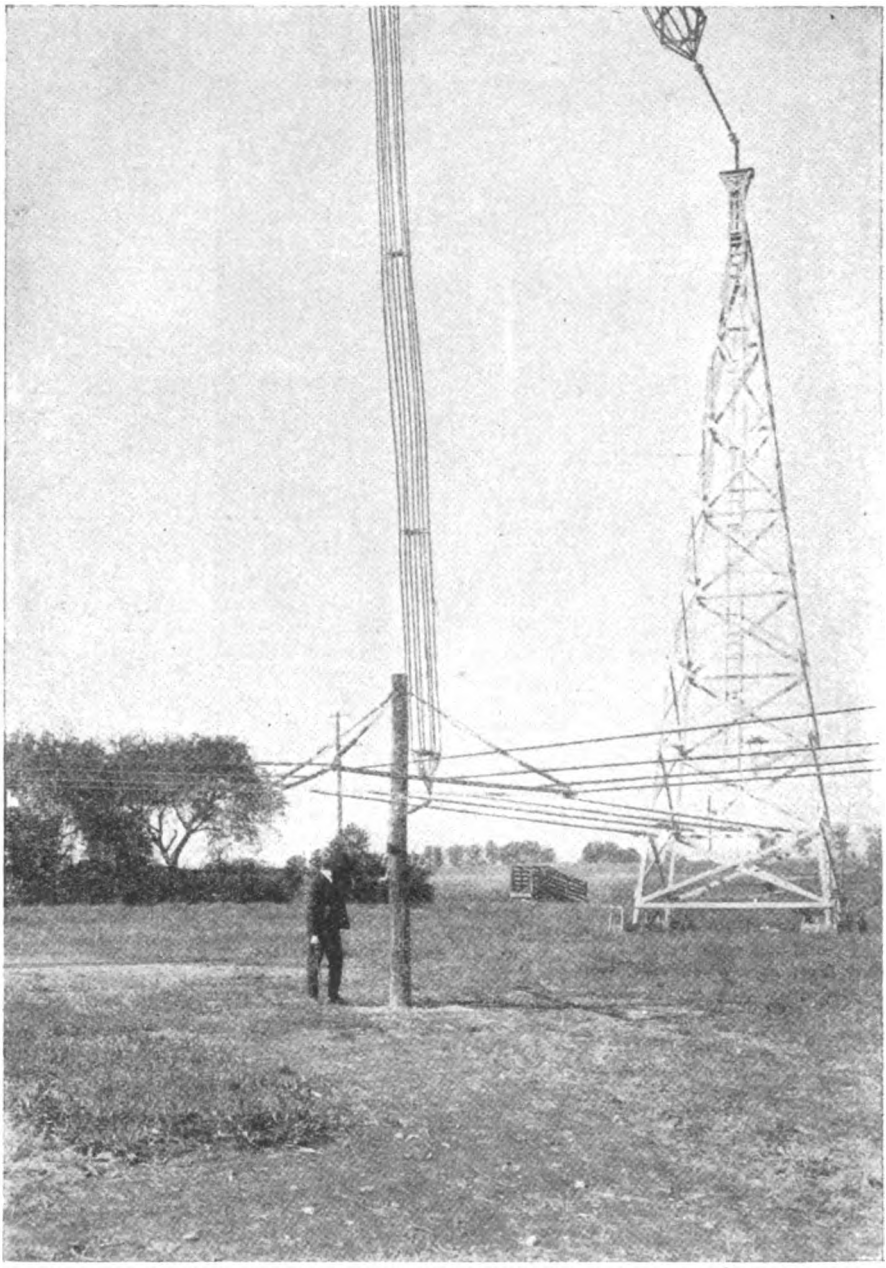

Armstrong Perry

Radio Joins the College Faculty

Some of the more progressive of American educators are beginning to realize the tremendous possibilities of radio as a means of disseminating education, not merely to small groups of students, but to all the residents of large areas. Here is shown the antenna of the broadcasting station WPAB of Pennsylvania State College, which is developing "extension courses" that may reach the peoples of an entire state. (See "THE UNIVERSITY OF THE ETHER," *page 37.*)

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Popular Radio

VOLUME V JANUARY, 1924 NUMBER 1

Avoiding Train Wrecks by Radio

The chief cause of railway accidents is the "human factor." Some one forgets, some one dozes off for a brief moment—and the damage is done. The most careful of men are fallible once in a while; the remedy is to make human error impossible by using automatic apparatus. This article describes how radio devices are contributing to this end.

By ROBERT G. SKERRETT

ONE of the most frequent causes of railway accidents is the uncertain human factor. Despite all that has been done to safeguard traffic, the fact remains that block signals, no matter how operated, do not always impress their warnings upon the man at the throttle. Time and again in the course of each year trains go speeding by these cautioning sentinels, sometimes because the semaphore or the light is obscured by fog or smoke, but once in a while because of some mental lapse or physical disability of the engineer.

The consequence may be a collision or a derailment entailing serious damage to property, or even the sacrifice of life. Be the outcome what it may, the annual toll is a heavy one.

Recognizing the fallibility of human nature and the hampering conditions of fog, smoke or snow in the air, the Interstate Commerce Commission decided several months ago upon a momentous step in the direction of increased safety of railroad operation. It has ordered that no fewer than forty-nine of our great railways shall either equip their lines with some type of automatic train-control apparatus by July, 1924, or shall give satisfactory reasons for not doing so.

This attitude on the part of the Commission was based upon the knowledge that some of our inventors have brought such train-control devices to an acceptable stage of dependability. The systems devised have taken various forms, but all of them are designed not only to arouse the engineer to a state of alertness but automatically to slow up his train and bring it to a stop if, for any reason, he neglects to heed the visual signals of the semaphore or those other signals transmitted to him by the system of automatic control.

One of the simplest methods of train control depends on the growing appli-

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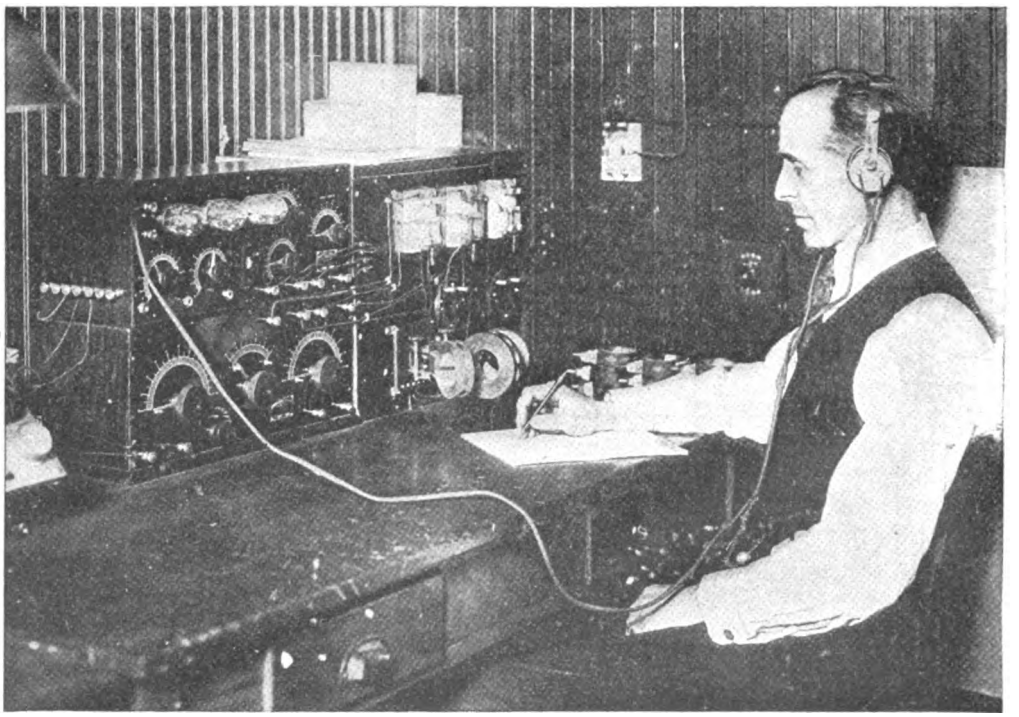
cation of radio telephony to the problem of communicating with the moving train. All radio engineers are familiar with the fact that radio impulses from wires strung along the track can be communicated to parallel wires fixed to the train, as in the usual systems of carrier-current radio or "wired wireless." Of course, a transmitting device on the train can operate such a system in a reverse direction so that signals from the train can be sent to the wires along the track and thence to a central control station anywhere.

By this method it is possible for the dispatcher at a railway division point to be in constant touch by telephone with the engineer of a moving train and thus to control its operation almost as perfectly as though he himself held the throttle. And if the engineer is ill or inattentive and thus runs by a signal set against him the dispatcher can communicate at once with the conductor or any other official on the train so that assistance can be sent instantly to the cab of the locomotive.

It is simple enough to equip these systems with call-bell devices controllable from the dispatcher's office so that the instant attention of the engineer or the trainmen can be secured whenever necessary. It is possible, even, to install on the train a system of relays actuated by radio signals, like the relays used in the automatic radio control of unmanned battleships and airplanes. These relays, adjusted to be sensitive only to special sets of signals, can be used by the dispatcher to stop the train at any



Keystone View Co.

THE RADIO TRAIN DISPATCHER

Using ordinary transmitting apparatus connected with wires strung along the track parallel with the moving train, the dispatcher can communicate at any instant with the conductor on the train. The train movement is thus under constant control from the central office. The set shown was used in the dispatcher's office at Nashville, Tennessee, during trials on the Nashville, Chattanooga and St. Louis Railway.

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Keystone View Co.

HOW ANTENNAS ARE ATTACHED TO RAILWAY CARS

The antennas of each car are separate; they are indicated in the illustration above by B. These antennas are connected together by the leads A, so that there is practically one long antenna that covers the entire length of the train.

instant without reference to the engineer at all.

Indeed, so extensive are the present resources of the experts in the remote control of machinery by radio that it would be perfectly possible to dispense altogether with the engineer and to direct unmanned locomotives from a central office; stopping and starting them, increasing or reducing speed when necessary, and performing all other operations by radio signals exactly as ships, airplanes and motor cars have actually been controlled on many occasions.

But while all such systems that depend upon radio signals from the dispatcher do eliminate the dangers arising from a failure of the visual signal system or from an error of the engineer, they still contain an element of human fallibility. They remain dependent upon the dispatcher, who must send the proper radio signal at the proper instant, and they also depend upon this signal getting through to the train wtih sufficient strength and accuracy to actuate the proper relay. A really perfect system of train control must eliminate even this source of failures and mistakes. It must be completely automatic, not dependent upon the action of any man, either on the train or elsewhere. And it is desirable that this perfect system should involve the simplest possible mechanical and electrical apparatus, so that natural accidents (as for example, a thunderstorm) will not put the system out of business.

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THE MAGNET THAT SAYS "STOP!"

If the engineer runs past a block when he should not do so, this brake-application magnet (one of which is situated at the entrance end of each block) operates automatically to set the brakes.

A number of such purely automatic and accident-proof systems have been devised. Some depend upon radio waves sent along the rails and effective within the train to signal the engineer or to operate relays, just as the usual electric currents in the rails are effective now to operate the signals of the block-signal systems. Others depend upon radio-transmitting antennas of small range, or upon magnets, placed from point to point along the track and adjusted to stop the train if it runs past them too rapidly or if it passes them at all when the signal says that it should halt.

The radio transmitters that are useful for this purpose are merely loops or condensers supplied with high-frequency current. They operate just as all radio devices operate, the closest analogy to them in familiar radio science being the short-wave directed radio now being experimented with so actively both here and abroad.

These radio methods have much promise for the future, but they do not seem to have reached, as yet, so complete a perfection as has been attained by the magnetic devices. Most of the systems actually installed and tried out under service conditions, if not all of them, depend upon the use of magnets. Permanent magnets or electromagnets are placed at proper points along the track and these influence, by electromagnetic induction, other magnetic or electric devices placed on the trains that pass over them.

One of the most complete of these magnetic systems is the achievement of an eminent electrical engineer, Mr. Frank J. Sprague, who was assisted in this work by his son, Mr. F. Desmond Sprague. The system is the outcome of nearly a decade of research costing more than $500,000.

Most of us are familiar with the block signals spaced at suitable intervals along the right of way of a railroad. We know that they are placed there to inform the engineer whether he can proceed at full speed or at a slackened pace. If danger is near the semaphore or light will bid him halt. Now the purpose of the Sprague automatic train con-

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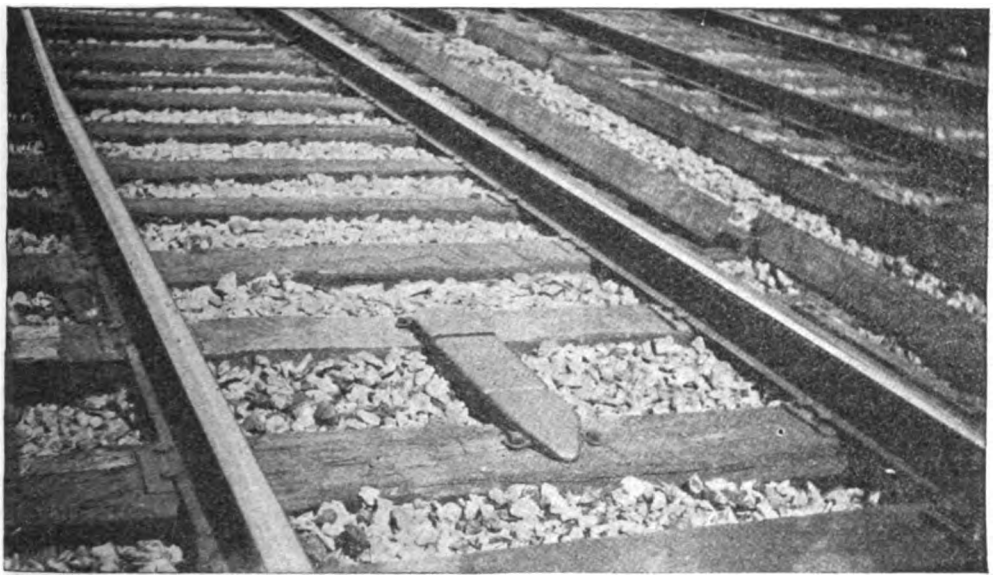

THE MAGNET THAT SAYS "GO AHEAD"

At the entrance end of each block is one of these magnets.. When the block is clear the magnet resets the apparatus on the engine so that the train can proceed.

trol is to repeat the indications of these block signals and, furthermore, to subdivide each block into smaller regulatory zones. This subdivision of the blocks not only adds to safety of traffic but it also keeps the transportation stream in motion with as few stops as possible. The average person does not realize how much time is lost in getting a train under way after it has come to a standstill or how much this costs in fuel wastefully consumed.

The Sprague system locates between the tracks in each signal block three independent magnets. The first is situated a short distance from the entrance to the block. The second is stationed at the critical point of the block, that is, a little beyond the middle of it. The third is not far from the exit of the block.

Magnets number one and number two are permanent magnets so constructed that they act to start the application of the train's brakes. Magnet number three is a reset apparatus which restores the control mechanism on the locomotive to its original state so that it is ready to function anew when it gets into the next block. All three magnets are linked electrically with the block-signal system, and the manner in which they perform is determined entirely by the orders transmitted through that system. Magnet number one is controlled by the signal at the entrance of the block, while magnets number two and number three respond to the warning of the signal at the exit of the block.

The magnets are sunk in the roadbed, between the rails, so that their upper surfaces are nearly flush with the wooden ties, where they are out of harm's way. Each of the first two or brake-application magnets is really an aggregation of several independent bar magnets, tucked away inside a water-tight metal casing and surmounted by two short, upright projections, called pole pieces. These pole pieces carry coils of wire which are connected with the regular block-signal system. When the track is clear current is fed to these coils in such a direction that this current opposes the ordinary action of the magnet and suppresses its magnetic flux.

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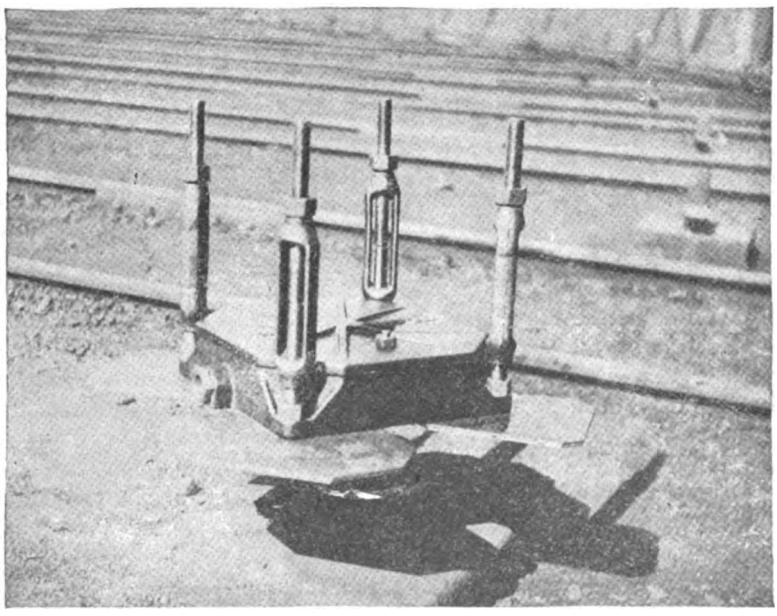
When the magnet is in this condition it is inactive and the sensitive element on the locomotive will pass through this "dead" field without being affected. That is, there is no automatic application of the brakes and the train is free to run on unchecked. The object of making the brake-application magnets normally active rather than normally inactive is a safety-first measure. Should any of the magnets cause the brakes to be set when the block really is clear this gives notices that the electric circuits are out of order and must be attended to.

The third or reset magnet placed near the exit of each block is not a permanent magnet at all. It is an electromagnet, and is energized from the signal just beyond it. If this signal is at "danger" no electricity reaches the magnet's coil and the magnet is powerless to reset the train apparatus as it would do if the succeeding block were clear.

The first two or brake-application magnets are fixed in the road-bed so that their magnetic fields are exerted vertically. On the other hand, the reset magnets are arranged so that their fields are parallel with the rails. Keep this difference in mind. Suspended beneath the forward end of the locomotive is a box from the bottom of which project two crosswise iron plates and two lengthwise ones. These plates are from three to four inches above the rails. The gap between them and the road-bed magnets is seven or eight inches. The crosswise plates collect magnetism only from the brake-application magnets, while the lengthwise plates respond only to the flux of the brake-application magnets.

Inside the box, which is water-proof, dust-proof and not itself magnetic, are two small metal armatures which are exquisitely sensitive to magnetic impulses and yet are so mounted that the jarring of the train does not disturb them. Depending upon whether the magnetic impulse to these armatures comes from the crosswise iron plates or the lengthwise ones, the armatures



THE MAGNETIC BRAIN ON THE LOCOMOTIVE

The projecting iron plates on this box pick up the magnetic impulses from the track magnets and thus supply the necessary signals to the engineer and to the automatic controls.

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Lackawanna Railroad

TELEPHONING FROM A MOVING TRAIN

As long ago as 1915 this apparatus was used in experimental tests of the possibility of communicating with moving trains by radio waves passing from wires stretched along the track to other wires carried on the train. The development of this system, interrupted by the war, is now active again.

make or break one or the other of two electric circuits. By this means they call into play the control apparatus on the train. Even though a train may rush past any of the magnets in a small fraction of a second, the iron plates that serve as magnetic collectors are sufficiently receptive to catch and transmit the magnetic flux to the proper armature.

We might liken the collector plates and the receiver armatures to our senses and the linking circuits to the corresponding nerves. These nervelike circuits converge in their turn, upon a metal box on the running board of the locomotive. In this sealed case, or brain, are the nerve centers, a group of three delicate relays capable of responding to electric impulses lasting only one-thousandth of a second. In complete correspondence with the magnetic signals from the road-bed these relays send electric orders to the proper valves and other mechanisms.

For example, the relays actuate two air valves which automatically move the engineer's brake valve by way of warning to him and also to discharge air to apply the brakes, either partially or completely, as circumstances may demand. These valves can be set to produce different braking actions to meet the special traffic needs of any railroad. Herein lies one of the admirable features of the equipment. It is thoroughly flexible.

There is also an automatic speed-control mechanism which is connected with an axle of the locomotive. This apparatus, likewise, can be set to stop the

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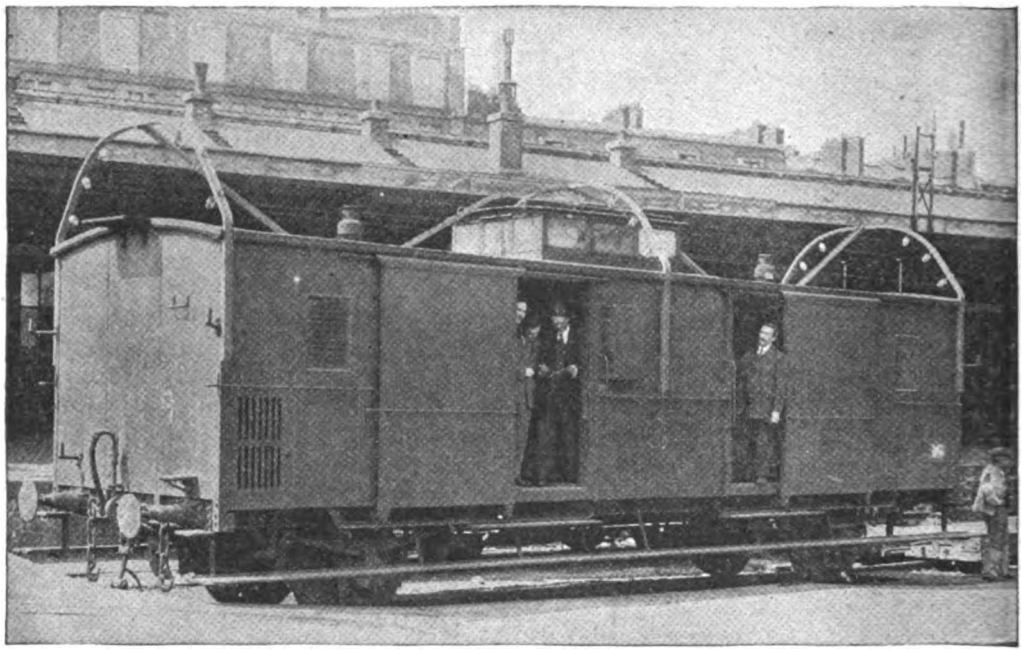

Boyer, Paris

RADIO TRAIN CONTROL IN FRANCE

This railway car of the French State Railways will have memories for members of the A. E. F. Fixed to the top of the car are the antennas used in the experiments now being carried out on train control by radio telephony between the dispatcher's office and the train crew.

train whenever its speed exceeds that prescribed in a "caution" block. Should the engineer be unmindful of the warnings given him, and release the automatically applied brakes with the intention of defying the control system, matters are taken out of his hands and the train is slowed up or brought to a halt.

Now let us see just how this system works. Assume that the train is about to enter a protected block and that it is speeding along at sixty miles an hour. You are standing on the floor plate of the locomotive where you can observe what goes on in the cab as well as the semaphores by the roadside. The last semaphore has been at "clear," and repeating this signal a little green light shines in the cab in front of the engineer. A duplicate green light glows on the opposite side of the cab before the fireman. All is well.

But the next semaphore is at "caution," and when the locomotive arrives at the first magnet beyond this semaphore the brakes are automatically applied, unless the engineer has already seen the semaphore and applied them. The brakes continue to retard the train until it has reached the prescribed safety speed, say forty miles an hour. Simultaneously with this automatic application of the brakes two yellow lights, meaning caution, takes the place of the two green ones in the cab.

Simultaneously, whenever the brakes are called into play by the impulse from the road-bed magnet, the lever of the engineer's brake valve moves under his hand. This movement is counted upon to arouse him if he has not noticed the signal just passed. He may be further warned by a whistle or horn in the cab.

The automatic equipment does not immediately take the control out of the hands of the engineer. He can return the valve lever to the brake-releasing position by exercising a vigorous effort.

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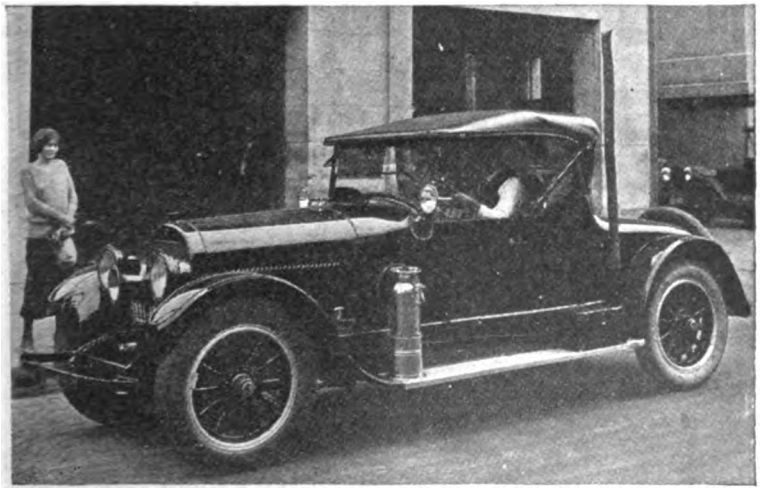
But if he tries to run his train above the prescribed "caution" speed he is forced to surrender control the moment the train reaches the second brake-application magnet. If the speed is then still excessive the brakes grip the wheels again and hold on until the train is slowed to the predetermined caution speed of forty miles an hour. At the second magnet the audible signal is once more announced in the cab and the yellow lights again blink their admonition.

Let us suppose that the engineer is perverse. Having left the first and the second magnets behind, he believes that he can beat the system from there into the nearing block. He forcibly releases the brakes and opens up the throttle. The train gathers prohibitive headway. But upon arriving at the third or reset magnet the engineer is in trouble again. This magnet, instead of restoring the train-control mechanism to normal, steps in and dominates the situation. It causes an emergency application of the brakes which stops the train abruptly. Before the train can start again the engineer must descend to the ground and press a releasing button located below the cab. This final functioning of the reset magnet effectually prevents the train being wilfully driven past a semaphore that demands a halt.

It should be understood, of course, that if the man at the throttle is careful and does of his own volition whatever the wayside signals bid him do, then he anticipates the road-bed magnets and his train is at all times subject to his own control. The object of the Sprague system is to serve merely as an auxiliary to the block-signal system. It is not designed to stop a train so long as that train is moving in accordance with the traffic regulations.

The system is actually in use on a five-mile stretch of track between Ossining and Tarrytown, New York. Months of daily testing have shown that the magnetic impulses can be relied upon to command the situation whenever it is necessary that they do so. With uncanny certainty they reach across the eight-inch gap under the train and instantly set in motion the series of corrective mechanisms. The flow of traffic is restrained only so far as may be necessary to insure safety, but no train can move when further progress would invite disaster.



THE RADIO-EQUIPPED CAR OF A FIRE CHIEF

In order to keep in constant touch with headquarters, the head of the Dallas, Texas, fire department has equipped his official auto with a receiving set, on which he picks up all fire signals broadcast from station WRR.

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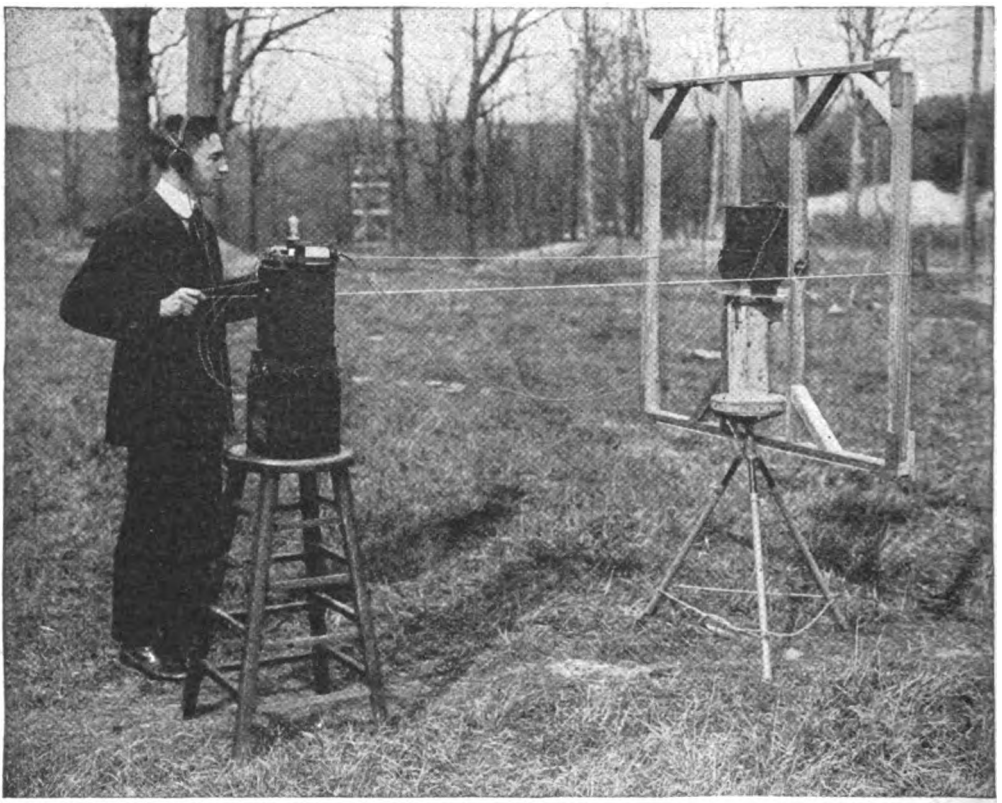

Bureau of Standards

EXPLORING THE MYSTERIES OF RADIO TRANSMISSION

With this movable loop connected to delicate receiving and recording apparatus the scientists of the Bureau of Standards are investigating the distortion of radio waves during transmission, one of the radio mysteries that will bring rich rewards to the experimenter who succeeds in solving it.

WHERE FORTUNES AWAIT

Unlimited opportunities lie before the radio amateur, the radio fan and the scientist for solving the mysteries of radio phenomena. This article points out what some of these mysteries are.

By HENRY WOODHOUSE

AN eminent doctor recently called on me to ask how he could get a transmitting and receiving radio station.

"Where do you want to transmit to?" I asked.

"Any part of the world," he answered. "Two of my patients are in Paris, one in London, one in Egypt, several at various summer resorts, and two on the Pacific Ocean *en route* to China and Japan. With a radio I can keep in touch with them daily and advise them instantly regarding their health. If I don't prepare for it they'll soon find a more progressive physician."

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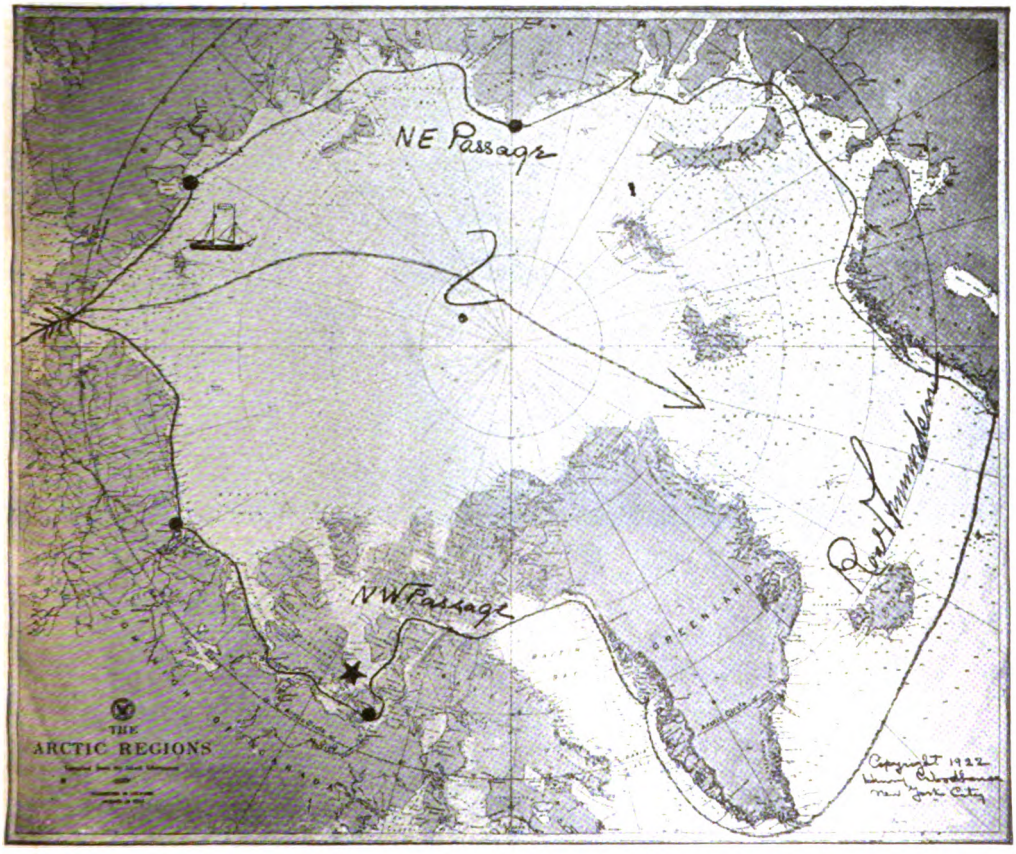
I had to admit that the argument was convincing, although I advised him that the matter of transmitting would be too complex for a physician and he should make arrangements with one of the large corporations.

"How many physicians are there in the United States?" I inquired.

"Over one hundred thousand," he answered.

It may seem visionary to state that it will not be long before every physician will have to have a radio telephone. But it is not more visionary than it appeared twenty-five years ago to say that physicians would soon have to have the telephone. Alexander Graham Bell, the inventor of the telephone, told me that even in his wildest dreams he never dared to think that doctors would ever find it necessary to have telephones in their offices. What would you think now of a physician who did not have a telephone in his office?

The incident is significant. The stupendous spread of interest in radio, by bringing into being a corps of hundreds of thousands of radio experts, professionals and amateurs, has created a world-wide organization, large enough and equipped with the means necessary to attack the most profound



DOES THE MAGNETIC POLE AFFECT RADIO TRANSMISSION?

Captain Amundsen's ship MAUD *is now frozen in the ice in approximately the place shown on this map. It is planned to drift across the pole, locked in the ice fields. The* MAUD *is sending out daily radio messages; if radio amateurs will listen for these messages and record the facts about them they may help to solve the great mystery of the effect of the North Magnetic Pole (shown by the black star) on radio transmission.*

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problems that have heretofore baffled science, the solving of which will, coincidentally, solve the basic problems that stand in the way of further progress in radio transmission and the fundamental progress of electric art and science.

If we can solve these problems radio will become a five-billion-dollar industry; the electrical industries will advance until they equal twice as much more. For it is the same group of fundamental mysteries that underlies both radio and all the other uses of electricity and magnetism.

The future of radio—to take only this one among the possibilities of electricity—is so immense that it is beyond our power to grasp. The world is ready to adopt radio in every branch of human endeavor, and will do so as soon as ways are found to so control radio waves that a million or more messages can be sent and received simultaneously from as many stations, without mutual interference, and as soon as natural electric, magnetic and atmospheric interferences are eliminated or controlled.

To get an idea of the developments to be expected you must ask yourself what radio can do in co-operation with the hundred or so gigantic industries like the shipping industry, the railroad industry, the automobile industry, the telegraph, telephone and cable industries, the oil industry; in every branch of the commercial world, such as banking, buying, selling, negotiating contracts and concessions; in the transmission of news, photographs and images of events; in the various professions, and at home and in every phase of daily life.

For instance, in the near future it may be a legal requirement to equip automobiles with radio-telephone receiving instruments, to facilitate the control of interstate traffic. Then there will be a sudden demand for over 13,000,000 receiving instruments, one for each registered auto. This development is dependent upon better control of transmitting and receiving and on the neutralizing of local magnetic and other natural or artificial phenomena created by railway and electric systems, steel buildings and other local conditions.

The better control of radio will make it possible for millions of firms and individuals to communicate with their correspondents by radio messages, received on typing machines at the receiving end as fast as they are typed at the sending end.

The solution of these pressing radio problems may make it possible, also, to realize the task of supplying to air craft, water craft or land craft, as well as to machinery, power from central radio stations—as proposed by Nikola Tesla to me ten years ago.

In the not distant future we may expect that audible broadcasting will be supplemented by visible broadcasting of what we may call radioscapes, through systems that will make it possible to project the pictures of ships and trains in transit and of other events on a screen in any part of the world.

A baseball game in New Zealand will be projected on a screen in a theater or private home in New York or on ships at sea; an opera performance in New York will be seen as well as heard, all over the world; the progress of ships at sea will be shown on the screen at the offices of the shipping companies, or in the homes of friends of persons traveling on the ships; it will be possible to see actions of congressmen and members of legislatures as well as to hear their addresses, and civic associations will no doubt maintain auditoriums in cities and communities where people may go daily to follow the acts of their legislators; the maneuvers of warships will be projected on screens in Washington where the naval authorities may follow them; and so on with every public branch of human endeavor.

Radio has always had a keen scientific appeal. But now it is becoming an

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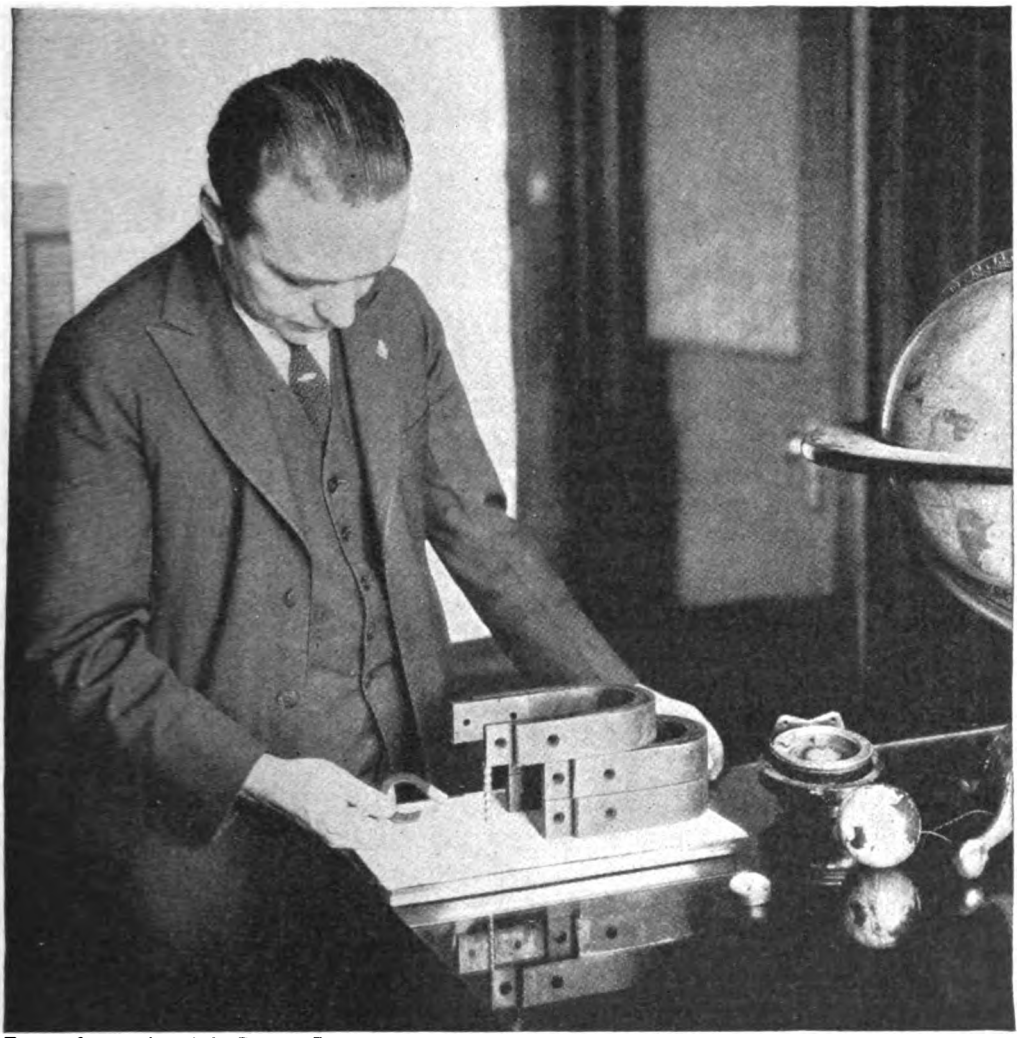

From a photograph made for POPULAR RADIO

RICHES WAIT FOR THE MAN WHO SOLVES THIS MYSTERY ABOUT THE NATURE OF MAGNETISM

No one knows, the author says, the nature of the forces that hold the string of little steel balls suspended from the pole of the magnet. Whoever finds out will rank among the immortals in science.

essential of everyday life, just as has the telephone, which now has over 15,000,000 subscribers in American territory. There are even greater prospects for radio provided we solve the problems that restrict the volume of radio traffic.

"How can we solve these problems," asks every radio worker who is ambitious to win fame or fortune from his art. So also asks every person who sees a possibility of using radio or electricity to solve some problem of business or of everyday life.

The first step is to see what the problems are.

As a result of twelve years of investigation and contact with leading scientists, who accorded to the writer the rare privilege of stating frankly what we know and what we do not know about fundamentals, the writer

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has listed over one hundred unsolved radio, electric and magnetic mysteries that await solution. The following are a few of them.

1. What are the sources of terrestrial magnetism? If these sources are inherent in the earth can they be so vast as to supply so enormous an amount of magnetic force for thousands of years without being capable of being tapped for power to drive our machinery, ships and automobiles?

2. Why is it that both radio and terrestrial magnetism diminish and fade away at the equator? Is it that radio is less strong there because it is unsupported by terrestrial magnetism or is it that both are diminished by some third mysterious phenomenon about which we do not know anything?

3. Why does the Aurora or polar lights, while disturbing telephone and telegraph service and creating radio disturbance in some regions, improve radio transmission in other regions?

4. By adopting the new theory that ether is a magnetic (or electromagnetic) flux can we explain the kinetics of the universe, providing a mechanical basis for computations which were limited, heretofore, to mathematical deductions and philosophic conceptions?

5. Do the radio signals from surface vessels, that are picked up by submerged submarines, travel over the surface of the water and then ground where the submarine is? Or do they ground immediately they are transmitted and follow or "hug" the bottom of the ocean? Or do they traverse the whole vertical depth of the water?

6. Are the phenomena of "static" and "atmospherics" the same below, on and beneath the surface of the earth? Or, to phrase it differently, is ground static the same as atmospheric static or are they entirely different, each requiring different means for its elimination or utilization?

7. Why is it that static disturbances are directional and come mainly from areas located at the magnetic equators, these areas being also the areas of maximum frequency of thunder storms?

8. Are sun spots, magnetic storms, polar lights, magnetic variations and static conditions simultaneous occurrences, interrelated causes and effects all originating from the same source?

9. What is the cause of the mysterious "dead spots" for radio transmission which have been found in the Eastern United States, in Alaska, in Europe, on the oceans, and elsewhere?

10. What forces associated with, or resulting from, the motion of the earth increase or decrease radio conductivity?

11. Is the electron responsible for magnetism, or magnetism for the electron, or neither? Is there an ultimate magnetic particle and what is its relation to the ultimate electric particle?

HOW RADIO MAY GO TO THE POLE

This airplane with which Captain Amundsen will try to fly across the ice-covered polar regions is equipped with radio so that communication with civilization may be maintained. Note the ski-like runners.

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From a photograph made for POPULAR RADIO

IS THIS WHAT BLOCKS THE POLAR RADIO?

With this small globe the author illustrates the magnetism of the earth. The point of the pencil indicates the end of a small bar magnet thrust through the globe to reproduce the magnetic axis of the earth.

12. What are the effects on the earth of the action of the sun in charging space with electric energy amounting to millions of billions of volts and with light amounting to innumerable billions of candle power?

When these questions, and the scores of others like them, have been answered we shall have gone a long way toward solving the practical problems of radio and of electrical engineering. Practically every one of these problems affords a stupendous opportunity for fame, rewards and distinction to whoever succeeds in finding the answer to it.

An experimenter, a radio amateur provided only with the simplest equipment, may in seeking the answer to one of these questions discover some new principle or some new method of application of old principles, some utilization of forces and elements now ignored, just as Edison discovered many new principles while experimenting to obtain entirely different results, just as Roentgen discovered the X rays by accident, just as De Forest evolved the revolutionary audion lamp from observing, while experimenting, that the discharge produced by a spark coil affected the intensity of the gas burner in his lodging room, and just as Ampere discovered the principles that brought him fame while working as a village locksmith.

"Why do we not know these things?" and "Tell me where to begin?" are the two questions I have asked the world's leading scientists—and in turn I have been asked by hundreds who have heard

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my lectures and read my statements on some of these subjects.

I have space here to mention only a very few of these problems. One of the most alluring of them is that of the nature of magnetism. It is a subject about which we know almost nothing but which probably, nevertheless, is the most important of all to the future of radio and of electricity.

What *is* this mysterious something that we call magnetism, that penetrates everything and is to be found everywhere? Where does it come from? Why is the earth magnetic? What are the magnetic poles? How has it been possible for the magnetic poles to magnetize everything in the earth and, undoubtedly, in the surrounding atmosphere without the source becoming exhausted?

The world cannot answer these questions. Captain Roald Amundsen, who studied magnetism since boyhood and who actually lived over a year in the region of the north magnetic pole in order to study the phenomena there, told me:

"Magnetism is more fundamental and more wonderful than electricity. We know only very little about it."

A small compass, a piece of lodestone, a magnet, a half ounce of iron fillings and a dozen needles, the whole costing about $3.00, will demonstrate more mysterious phenomena than the collective knowledge of mankind can explain today.

It is a curious commentary upon man's proverbial enterprise that although billions of persons—or an average of two billion every fifty years—have lived and died since the Chinese began using the magnetic compass, about two thousand years ago, only half a dozen men ever tried to follow the compass to the earth's magnetic poles to find out what the source of this phenomenon is; and of this half dozen, only one, Captain Amundsen, stayed in the magnetic polar regions a number of months to study the phenomena that occur there.

A number of the most pressing practical problems of radio are related, presumably, to this matter of the earth's magnetism. One example is the frequent phenomenon of variable path of waves in radio transmission. We are reminded by Marconi and other authorities who have opportunity of obtaining continual data of such variations that signals from stations at great distances do not always retain their direction along one great circle, but reach the receiver from either way or various ways round the earth. Marconi reports:

"The observers noted American signals from Radio Central and from Tuckerton coming from a direction which indicated that they preferred to travel a distance of three-quarters of the way round the earth, rather than come by the shortest way round."

Another interesting and extraordinary result was noted on several occasions, according to the report of Mr. Tremallen from Rocky Point, New Zealand, where during last March the signals from Nauen appeared to travel to him *via* the South Pole, whilst those from Hanover, also situated in Germany, and not very far from Nauen, appeared to prefer to travel *via* the North Pole.

Why? Nobody knows, but we may explain the phenomena if fifty thousand radio experimenters report for six months what they hear at different times of the day and night, because when such reports are tabulated they may make evident facts which we do not even suspect at present.

The *Maud*, the ship of the Amundsen Arctic Relief Expedition, frozen in the slowly drifting polar ice, is sending two radio weather reports each day from its powerful plant. These are received across the North Pole, at European stations, but, as far as has been ascertained, are not received in Alaska, Canada and the United States.

What is it that prevents the *Maud's* daily radios from reaching the stations

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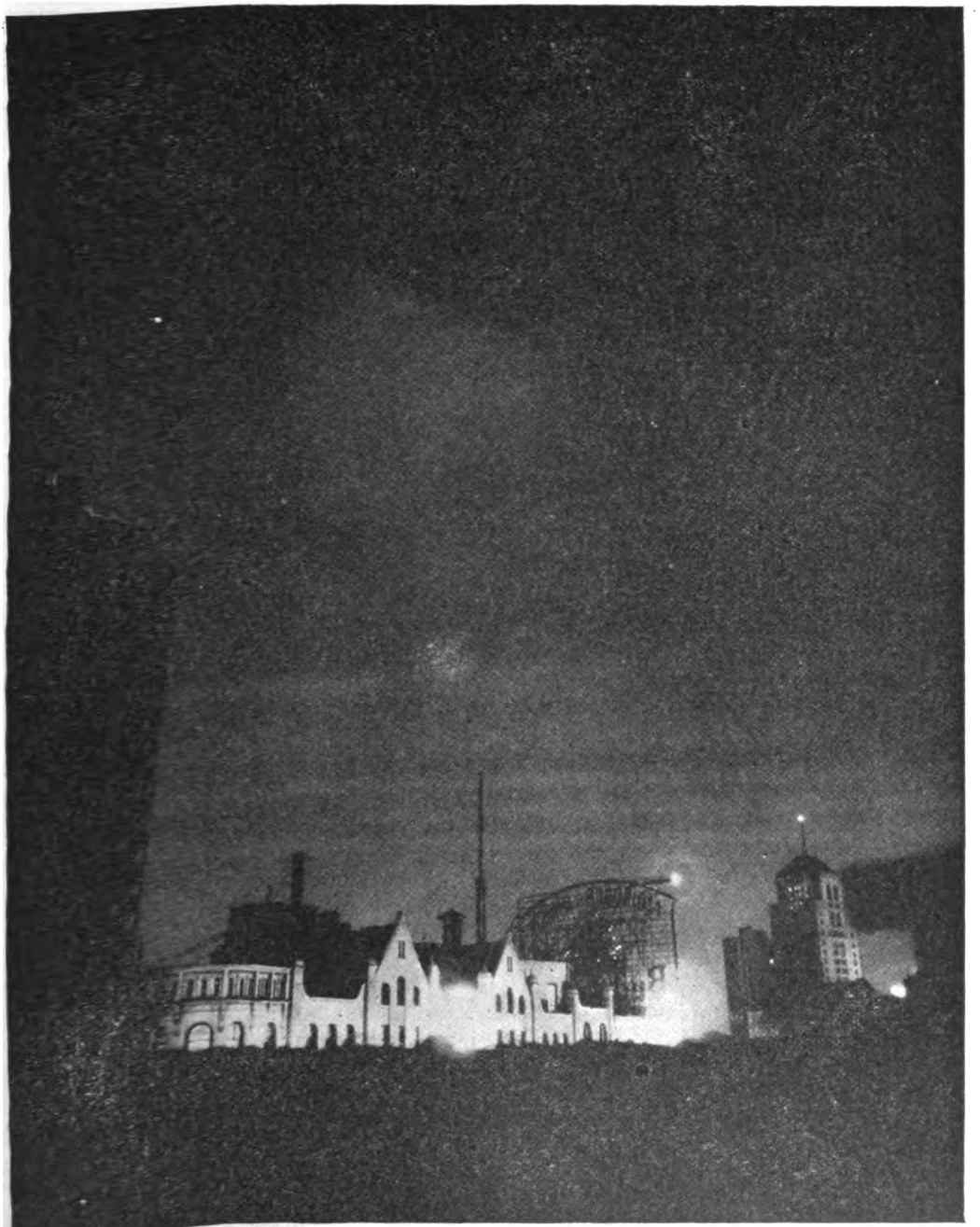

From a photograph by William Henry

WHAT EFFECT HAS THE NORTHERN LIGHTS ON RADIO?

The radio fans may be able to answer this question, the author believes, if they will co-operate in collecting information about it. This unusual photograph of the Northern Lights (or Aurora Borealis) was made from the top of the old Herald Building in New York, March 11, 1914.

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on the American continent? It cannot be the ice fields, the frigid air, the arctic storms, because there are more of these north of the *Maud* than south and west of her. The North Magnetic Pole, the center of the earth's magnetic attraction may be the cause, but nobody knows.

It is one of the mysteries that may be solved by the world's radio amateurs if they will listen for the *Maud's* daily radio signals and report whether they hear them or not. And any amateur who succeeds in solving this mystery, or any other one of the basic radio problems still unsolved, may find that it puts into his hands the key to wealth as well as to scientific distinction.

In May, 1916, when I delivered an address to the New York Electrical Society, I reported my experiences in testing the compass at high altitudes and the possibility of aerial torpedoes and torpedoes mounted on airplanes, directed through the air by radio, and pointed out that the mechanical problems of launching a five-ton load of T. N. T. through the air by radio would be solved before we could solve the problems of directing that load safely.

This is the case today. The Hammond system has demonstrated that even a battleship can be operated by radio, but we dare not venture a full size airplane, because of the many unsolved problems of radio transmission.

Directing military airplanes by radio cannot be undertaken so long as there is a possibility of interference. While the airplane would carry the load of explosive past a dead spot, which the airplane could easily negotiate, the radio could not cross that spot and the airplane would from that point on be adrift, guideless, a menace to communities below!

This gives an idea of the importance of some of these problems from a military standpoint. Many of them are equally important commercially.

Another one, which may or may not have a magnetic element, is the mystery of the disturbances known popularly as "static" or "atmospherics." Very little is known of these disturbances beyond the fact that they occur. The phenomena may be at times electric, at times magnetic, at times atmospheric. One of the important needs at present is to analyze the disturbances into these or other divisions. Only by learning their nature will we be able to screen them off or to utilize them, the latter being the most likely result because it is not natural with human beings to let power go unharnessed.

The genius of Tesla, in noticing that the stationary waves caused by a distant storm could be reproduced in the conducting layer of the earth by means of two synchronized oscillators, and utilized to explode submarine mines is an example of how we may utilize all "static" phenomena.

But first we must find out what the disturbances are. Do they originate in the crust of the earth, or in the atmosphere which wraps the earth, or from cosmic sources altogether outside the earth, or from all of these in combination?

This is one of the cardinal questions to be solved.

We must not forget that whatever the nature of these disturbing factors, they use the same conductive media as radio signals, therefore we may learn about both in studying either.

Were it possible for a radio experimenter to view the whole earth whenever his receiving instruments register the clicks and rattlings of static he would find, probably, that polar lights are flashing their dazzling streamers from points ranging from sixty to one hundred miles above the north and south polar regions and extending skyward, several hundred miles up.

Why? No one knows. It is one of the many unexplained phenomena which the radio experimenters may help to define, benefiting the art of radio transmission in so doing.

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WHY DO RADIO WAVES GO EVERYWHERE?

The airship and airplane high in the air, the submarine under the sea, the miner deep in the earth all receive radio waves, yet the nature of these waves and the medium that carries them is still a mystery that demands solution and that will hugely reward the experimenter who solves it.

By adding to their radio sets the simplest equipment used for determining magnetic variations,, the world's radio experimenters could supply in the course of a year data that might make it possible to establish the connection of the so-called "static" and "atmospheric" disturbances with the polar lights, the connection between polar lights and magnetic storms, the direction and geography of magnetic disturbances and other basic facts.

Radio engineers have been as prodigal with the natural resources available to them as other pioneers have been. Their attitude toward static and atmospheric disturbances is similar to that of the salt miners a century ago

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who cussed when they struck some stuff called petroleum while mining salt. They are just as wasteful as the railroad people who spent thousands of dollars wearing out brakes in slowing up electric trains going down hill. Now the salt miners who strike oil abandon the salt to take care of the oil, and the railroads use the downward journeys of trains to generate electricity to use to take the same train up the next hill.

The time is coming when what is now grouped under "static" disturbance and cussed by the radio experimenter, will be divided into categories, such as electrics to designate electric phenomena, magnetics to designate magnetic phenomena and atmospherics to designate phenomena caused by atmospheric conditions. Each will be utilized and used not only to advance the cause of radio and electric transmission but also to advance other industries, arts and branches of science.

We may obtain benefits of material value in everyday life, such as means of tapping the natural electric fields for cheaper power to drive machinery and to light the streets and homes of the most isolated communities.

It may come to pass that static and the polar lights, instead of being regarded purely as vagaries of nature that often disrupt the radio and telephone and telegraph service, may become signals that conditions are favorable for tapping the natural electric fields and for storing away electricity to drive our machinery for months to come.

Imagine the world-wide and lasting fame, to say nothing of more tangible rewards, that awaits the man who first succeeds in doing this. Every radio experimenter has unparalleled opportunities of winning fame and wealth by solving one or more of these basic scientific mysteries. There are opportunities for thousands.

Armstrong Perry

RADIO ENTERTAINS THE CROWD AT THE HENLEY REGATTA

The classic rowing event of England was marked this past season by pleasure craft equipped with receiving sets that kept the spectators interested, between the races, with broadcasts from London.

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From a photograph made for POPULAR RADIO

THE COMPLETED SET

The inventor, Mr. Cockaday, is here shown demonstrating his experimental receiver to Dr. E. E. Free and Raymond F. Yates.

HOW TO BUILD THE

IMPROVED 4-CIRCUIT TUNER

By LAURENCE M. COCKADAY, R.E.

It is estimated that there are now in use about 500,000 four-circuit tuners—first announced in POPULAR RADIO for May, 1923. This article describes a remarkable development of this set—a development that provides for AUTOMATIC TUNING, practically unlimited distance range, maximum volume of sound, excellent reproduction and no interference. This set is probably the most important contribution that has yet been made to the equipment of the radio fan.

—EDITOR

COSTS OF PARTS: *About* $95.00

RECEIVING RANGE: *Over* 3,400 *miles*

HERE ARE THE ITEMS YOU WILL NEED

Four-circuit coil set, units A, B, C, D;

A—primary winding, consisting of a single turn of tinned-copper, bus-wire 1/16-inch square;

B—secondary winding, consisting of 65 turns of No. 18 DSC copper wire;

C—stabilizer winding, consisting of 34 turns of No. 18 DSC copper wire; (coils A, B and C are wound on a hard-rubber tube, 3¼ inches in diameter and 5 9/16 inches long);

D—antenna tuning coil, consisting of 43 turns of No. 18 DSC copper wire double bank wound and tapped on hard-rubber tube, 3¼ inches in diameter and 1⅝ inches long.

E and F—Amsco vernier variable condensers, 26 plates, .00046 (.0005) mfd. (with 4-inch knob-and-dial and vernier knob);

G and H—Amplex grid-densers (small variable condensers);

I—Bradley-leak, variable ¼ to 10 megohms;

J1, J2, J3, J4 and J5—Melco vacuum-tube sockets;

K—Amsco filament rheostat, 6 ohms;

L1, L2, L3—Amsco filament rheostats, 20 ohms;

M1, M2, and M3—Pacent jacks, two double-circuits and one single-circuit jack;

N1 and N2—Amertran audio-frequency amplifying transformers;

O—Como input "push and pull" transformer;

P—Como output "push and pull" transformer;

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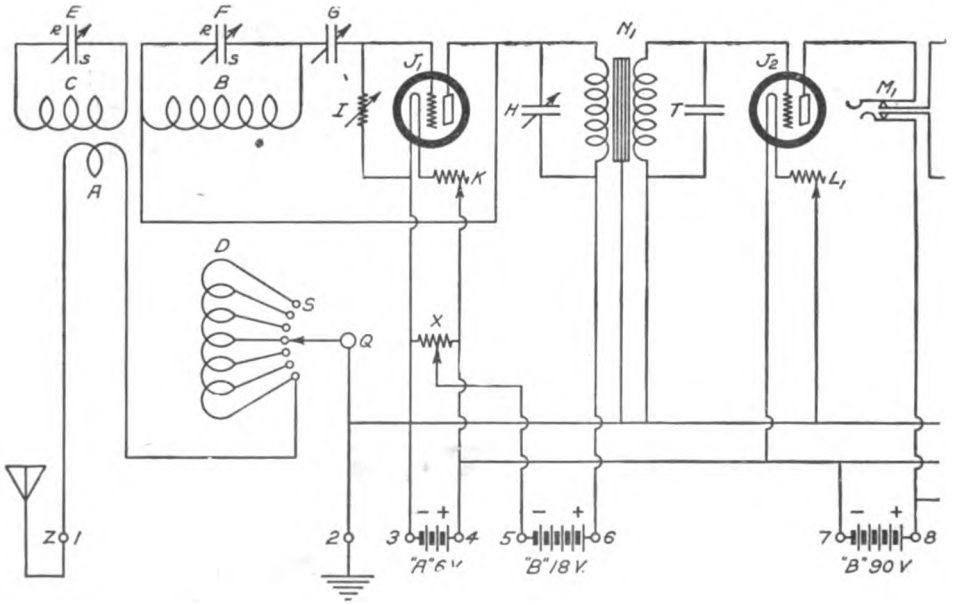
Q and R—switch levers and knobs;
S—switch points;
T—Dubilier mica fixed condenser .0005 mfd. (with lugs for transformer mounting);
U—Dubilier mica fixed condenser .00025 (with clips for grid-leak);
V—Durham variable grid-leak;
W1, W2 and W3—Lavite resistances, 48,000 ohms;
X—Amsco potentiometer, 400 ohms;
Y1, Y2, Y3—composition panels (7x24 inches), (3x2¼ inches), (and 1 foot x 12 inches). See Figures 7 and 9;
Z—binding posts;
AA—base;
AB—cabinet. (See Figure 8);
AC, AD and AE—brass brackets. See Figure 9;
varnished cambric tubing;
solder, etc.

THE letters telling of the radio enthusiasts' experiments and success with the four-circuit tuner have been pouring in so fast that the author has not had time even to try all the suggestions that they contain. Nevertheless he has managed to investigate every suggestion for improvement of seemingly worthwhile value that has come in and has picked out the good ones received and applied them to the set. Along with this have come letters from fans who have built the set described in the May issue of POPULAR RADIO and have for some reason or other not had the success with it that they should have had. Some have found the set ideal on local reception but poor on DX; some have found it wonderful for DX reception but not of enough volume on local stuff. Some write in that their set does not oscillate freely; some say that their set oscillates too much.

In every case, the trouble can be run down and it is almost always found to be due to a *mistake in connections* or to *apparatus of poor design or poor quality* that has been incorporated in the set. It should be remembered that a set is no better than its poorest part, and if one such part is used in the set, the whole set will be dragged down to this level. A poorly designed instrument can never be boosted up to the level of a good one by



THE COMPLETE WIRING DIAGRAM THAT INCLUDES—

FIGURE 1: *This diagram shows how to hook up the various instruments and parts in the circuit. It will be noticed that all the parts are given a designating letter*

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placing it in a circuit in company with good ones.

The improved circuit which is here described, besides having its recognized qualities of (A) unusual selectivity, (B) unlimited distance range, (C) ease of tuning, (D) truthful reproduction, also incorporates the following new features:

E—wavelength range, 150 to 675 meters;
F—wavelength calibration;
G—automatic tuning;
H—power amplification;
I—simpler construction;
J—adjustable circuit values.

The feature E makes the circuit suitable for amateur, broadcast, and commercial reception from CW, telephone, or spark transmitters.

Feature F allows the operator to set the dials for any particular wavelength he wishes to receive on, with the assurance that he will immediately pick up the station he is trying to get, without interference—providing the station is transmitting at the time.

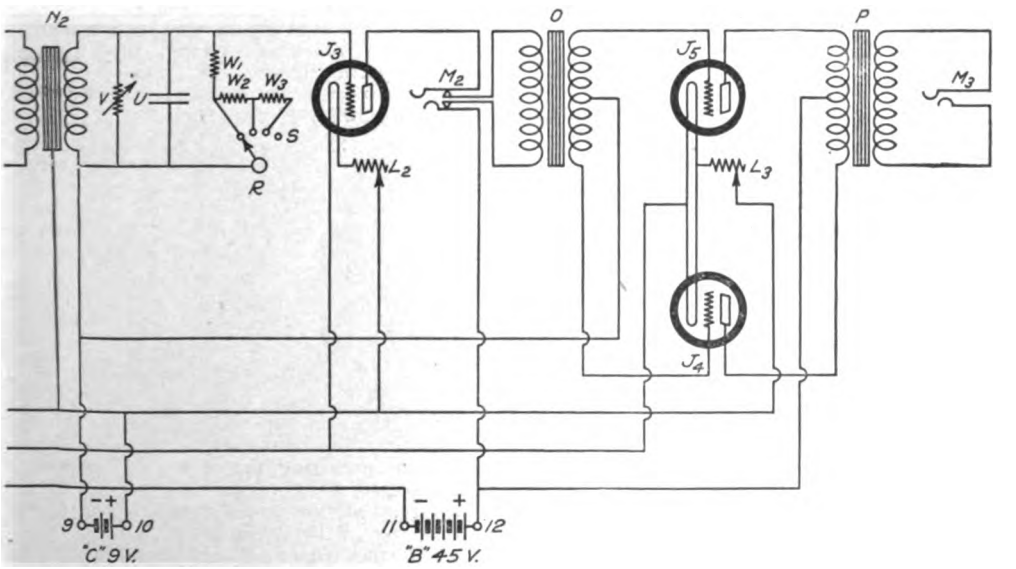
Feature G allows of tuning by a novice, even though he has no conception of what is happening when he adjusts the dials to the given settings.

Feature H allows of loudspeaker reception of DX* within 3,000 miles, and on account of the quality assured by the "push and pull" amplifier system, the reproduction of music and voice signals will be pure and undistorted.

Feature I is important because in building the first four-circuit tuner it was necessary to make special brackets for mounting the instruments, which were almost beyond the scope of the amateur builder. The new set is a structure in which all the instruments, except those that are mounted directly upon the panel, are fixed to the base, which is made of hard walnut wood. By this construction all the instruments are easily accessible and may be wired up with little difficulty.

Feature J is important because the various people who build the set may find that their set may oscillate too freely

*Amateur slogan for "long distance."



—THE TUNER, AUDIO AMPLIFIER AND POWER AMPLIFIER
which is the same as that given for the same units in the list of parts and the text. The binding posts are numbered. This eliminates the possibility of mistakes in wiring up.

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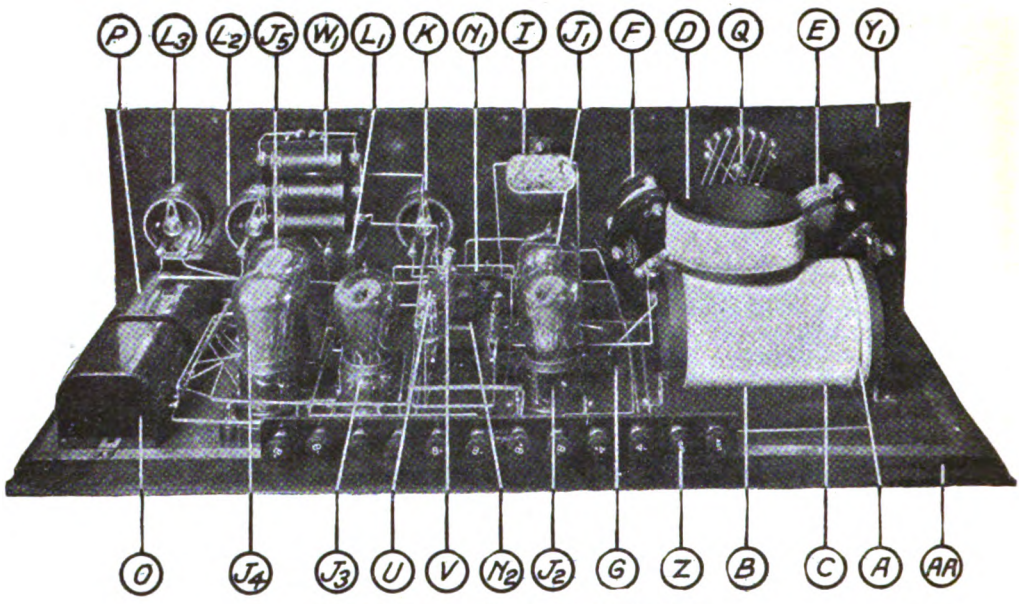

THE REAR VIEW OF THE SET

FIGURE 2: *This picture shows the general arrangement of all of the instruments fastened to the panel or the base. The exact locations for the instruments are shown in Figure 4.*

or not enough and if the grid condenser, the by-pass condenser, and the grid leak are made variable, these difficulties can be overcome and the set put into critical, regenerative condition.

The cabinet for the set is of simple construction; it consists of three sides fastened together which may be fixed onto the base and the panel by screws running through the base and the panel. The receiver is built on a 7x24-inch panel which is a standard size and can be obtained from any dealer.

Of course, the receiver does not re-radiate; this is really important in these days when closely coupled regenerative receivers are the rule, and we have so much whistling and squeaking accompanying reception in a locality where a number of these re-radiating receivers are in use.

The set is not susceptible to body capacity and needs no shielding at all; this is taken care of by the wiring of the set itself.

The wiring diagram is shown in Figure 1.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electric circuit. The same designating letters are used in the text and the list of parts at the beginning of the article.

¶ *The list of parts there given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

How to Construct the Set

After procuring all the instruments and materials for building the set, the amateur should set about preparing the panel Y1, (shown in Figures 2, 3, 4, 5, 6 and 7).

First of all the panel should be cut to the correct size, 7 by 24 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 7.

The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instru-

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ments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next mount the condensers, E and F on the main panel Y, by means of three screws each, and attach the knobs-and-dials. Be sure that the plates of the condensers are "all out" when the dial settings read zero. This is important if the calibration curve is to be used. Also be sure that the vernier plates of the condensers are "half in and half out" when the word "vernier" reads horizontally across the vernier knobs. Then mount the variable grid-leak I, on the panel with two screws, see Figures 2, 3 and 4.

Now mount the potentiometer X directly beneath the grid-leak by means of two screws.

Fasten the 6-ohm rheostat K directly above the hole for the first jack M1 by means of two more screws. The three 20-ohm rheostats L1, L2 and L3 should now be mounted in their respective positions to the right of the 6-ohm rheostat K.

Then mount the two switch levers and knobs Q and R on the panel, and also the switch points S. (See Figures 2, 3, 4 and 6.)

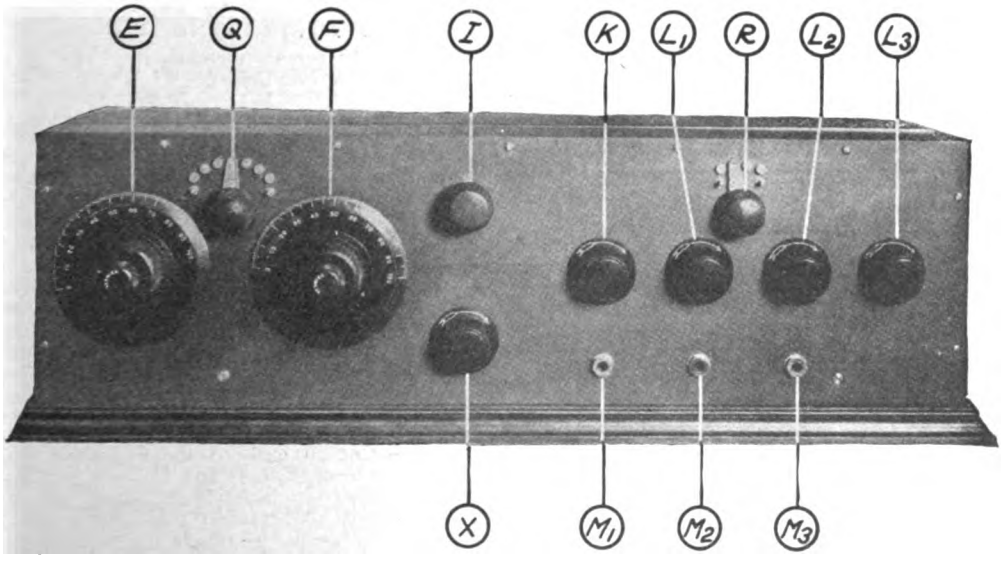
Next mount the three jacks M1, M2 and M3 in their respective places at the lower right end of the panel.

The correct positions on the panel for all these various instruments are shown in Figure 3, where all the knobs and parts are designated by the same letters as appear in the text.

The complete panel should now be attached to the wooden base by means of two small angle-brass brackets AC, see figures 2, 4, 5 and 9. The two holes for these brackets are shown in the drilling plan of the panel Y1 in Figure 7.

Now mount the coil set A, B, C and D with two screws fastened through the brackets AE as shown in Figure 4. Then fasten the five tube sockets J1, J2, J3, J4 and J5 in their respective places as shown in Figure 4.

Next fasten the two transformers N1 and N2 to the base, as shown in Figures 2 and 4. The first transformer N1 is attached to the base by slipping the small metal leg underneath the detector socket and fastening with the same screw as that used for one side of the detector socket. This gives close spacing. It will be noted that these two transformers are placed at right angles to each other. It should also be noted that the sockets are mounted with the slot facing a specific direction so that the grid terminals will be closest to their respective points of connection. (See



THE PANEL VIEW OF THE RECEIVER

FIGURE 3: *This gives an idea of how the set looks from the front and as the dials and knobs are marked with letters which correspond to the instruments to which they are attached, the prospective operator will have no trouble in locating the various tuning controls as they are explained in the instructions for tuning automatically.*

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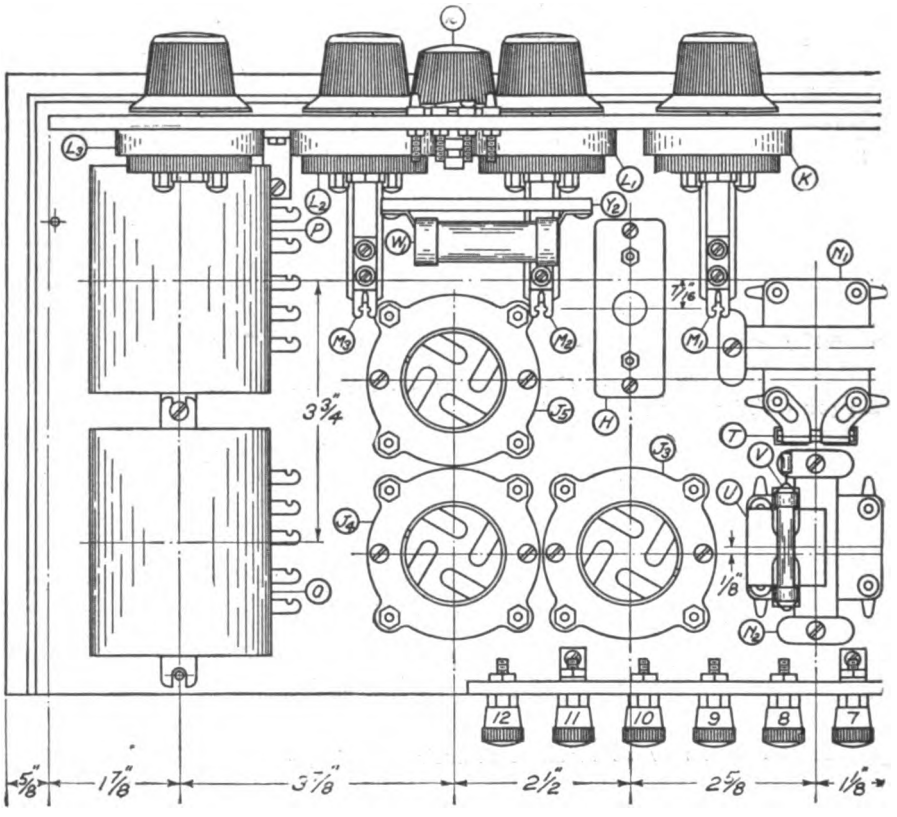

THE WORKING DRAWING FOR CONSTRUCTION

FIGURE 4: *Here are shown the correct positions for the various instruments. The positions are given, center to center, for all instruments.*

Figure 4.) This makes for short leads.

The next job will be to mount the transformer O at the rear of the base, and the transformer P close to the panel Y1. These two transformers are fastened to the base by means of two screws, one through the leg of transformer P near the panel, and one through the remaining leg of this transformer and the adjacent leg of transformer O. The remaining leg of transformer O will be held by one of the screws which are inserted up through the base and which hold the cabinet to the base.

Now mount the condenser T across the secondary terminals of the first transformer N1 and mount the condenser U and the grid-leak V across the secondary terminals of the second transformer N2. This is clearly shown in Figure 4.

The next job is to screw the two small rectangular-shaped variable condensers G and H in their respective positions as shown in Figure 4. These two instruments are mounted by two screws for each condenser.

Now cut the small connection block Y3 out of composition panel material, to the size shown in Figure 9 and drill for the binding posts. This panel should then be mounted on the base AA, by means of three small brass brackets AD constructed as shown in Figure 9. See Figures 2, 4 and 5 for mounting the connecting block.

The last job is to cut the small composition panel Y2 for mounting the three resistances W1, W2 and W3. This is done as shown in Figure 9, which gives the dimensions for drilling and shows the manner in which the units are mounted. As this panel is supported by the wiring of the set, the directions for mounting it will be left until later.

How to Wire the Set

The design of this set is such that the grid-circuit wiring of each of the five tubes may be made extremely short and isolated from the other circuits. In fact, all the tuning circuits and leads are so arranged that short connections may be used. As this is the case, the set may be wired with bus-bar with little loss in efficiency.

A tinned-copper wire is recommended. It should be about 1/16-inch square. All connections should first be shaped so that they will fit and then soldered in place. Start wiring the filament circuit as shown in the diagram in

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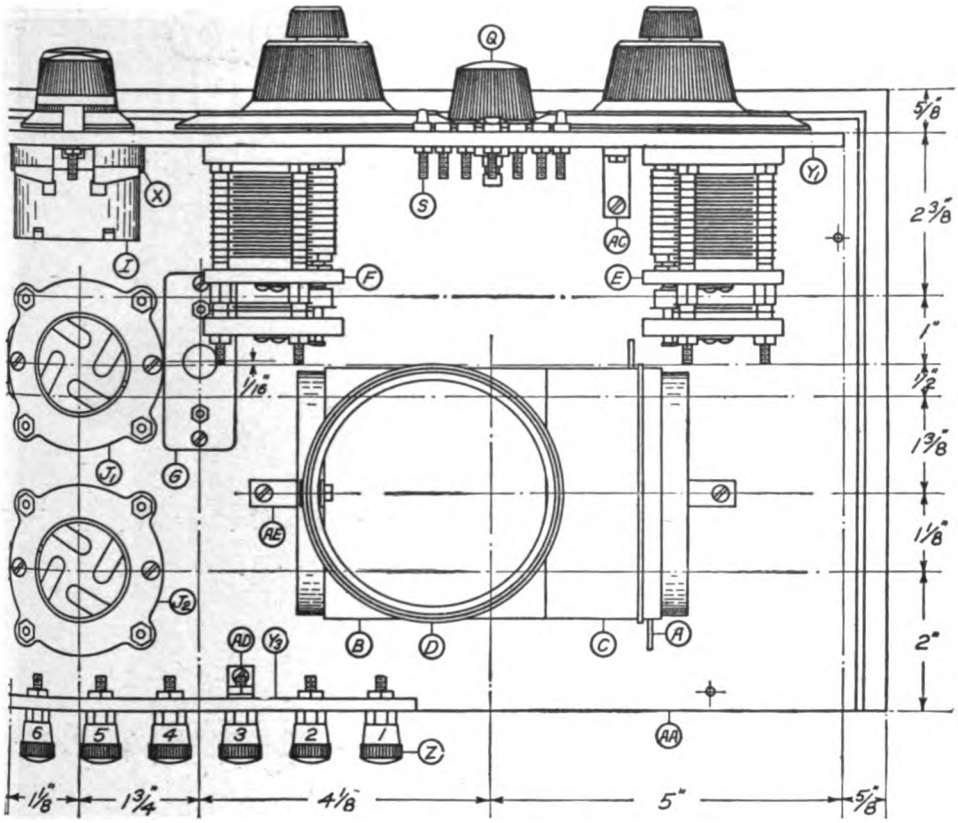

Figure 1. Be sure to include the rheostats in the correct side of the filament circuits. *This is important!*

In wiring up the potentiometer X be sure that the left-hand post of this instrument is connected to the negative "A" battery and the right-hand post is connected to the positive "A" battery.

Run a wire from the antenna post and loop it around coil C, one turn (forming winding A) spaced ¼ inch in from the outer end of the winding as shown in Figure 4. Run the other end of this loop over to the top end of coil D and from there over to the first switch point on the panel Y1, then connect up the rest of the switch points to their respective taps on the coil D. The switch lever Q should now be connected to the ground binding post and the negative "A" battery post on the connection block Y2.

Now wire up the two condensers E and F as shown in Figure 1, with the rotor and stator plates connected as shown in the diagram. Then wire up the grid circuit of the detector tube which includes the condenser G and the grid-leak I.

Run a wire from the middle post on the potentiometer X to the detector negative "B" post on the connection block. This is the fifth post from the right (looking at the set from the rear). The sixth post should be connected with a wire over to the B+ terminal of the primary side of the first transformer N1 with the remaining terminal connected to the plate terminal of the first tube socket. Now connect the small variable condenser H, by two wires, across the primary of this same transformer N1.

Next connect up the secondary of transformer N1 to the correct terminals of the second tube socket.

Then wire up the plate circuit of the second tube which includes the primary of the second transformer N2 and the first jack M1. The seventh binding post on the connecting block is for the negative 90-volt amplifier "B" battery and the eighth post is for the positive 90-volt amplifier "B" battery, which is connected to the second-tube plate circuit.

Now connect up the secondary circuit of the second transformer N2 to the grid circuit of the third tube. The ninth binding post on the connecting block is for the negative "C" battery and the tenth binding post is for the positive "C" battery.

The resistances W1, W2 and W3 which are fastened to the small panel Y2 are now connected with bus-wire to the switch points S and switch lever R and also to the secondary terminals of the second transformer N2 as in-

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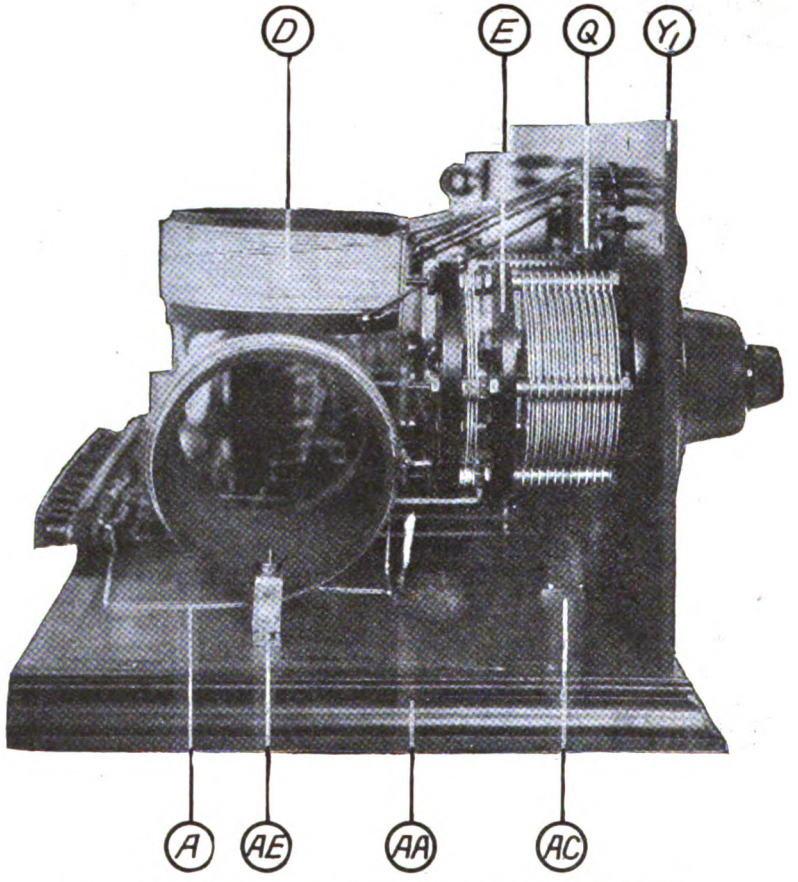

VIEW OF THE SET AS SEEN FROM THE LEFT

FIGURE 5: *This photograph shows the way to mount the condensers and the coil set, and specifically the manner of attaching the single turn of bus bar for the coil A.*

dicated in the wiring diagram and shown in Figures 1, 2, 4, and 6.

Now connect the plate circuit of the third tube which includes the second jack M2 and the proper connections on the input transformer O which are printed on the bottom of the transformer. The eleventh post is for the negative terminal of the extra 45-volt "B" battery used on the two last stages of amplification. This post should be connected by a wire to the eighth post. The twelfth post is the positive terminal of the extra forty-five volts of "B" battery. This should be connected to the plate circuit of the three last tubes as shown in the wiring diagram in Figure 1.

Now connect the remaining terminals of the input transformer O to the grid circuit of the last two tubes, including the "C" battery connection.

Connect up the plate circuit of the last two tubes which includes the primary connection to the output transformer P.

The last job in wiring is to connect the two secondary terminals of transformer P to the two terminals of the last Jack—M3. This completes the wiring.

How to Install the Set

After the set has been completely wired, the cabinet may be attached by means of wood screws inserted up through the base into the bottom edges of the cabinet and by smaller wood screws (nickel plated) inserted through the panel into the edges of the cabinet.

The binding posts Z on the connection block will now protrude through the slot cut for them in the back of the cabinet.

To connect the set, do the following:

Attach the antenna wire to the first binding post at the right (looking from the rear).
Attach the ground wire to the second post from the right.
The third post from the right should be connected to the negative "A" battery, 6 volts.
The fourth post from the right should be connected to the positive "A" battery, 6 volts.
The fifth post from the right should be con-

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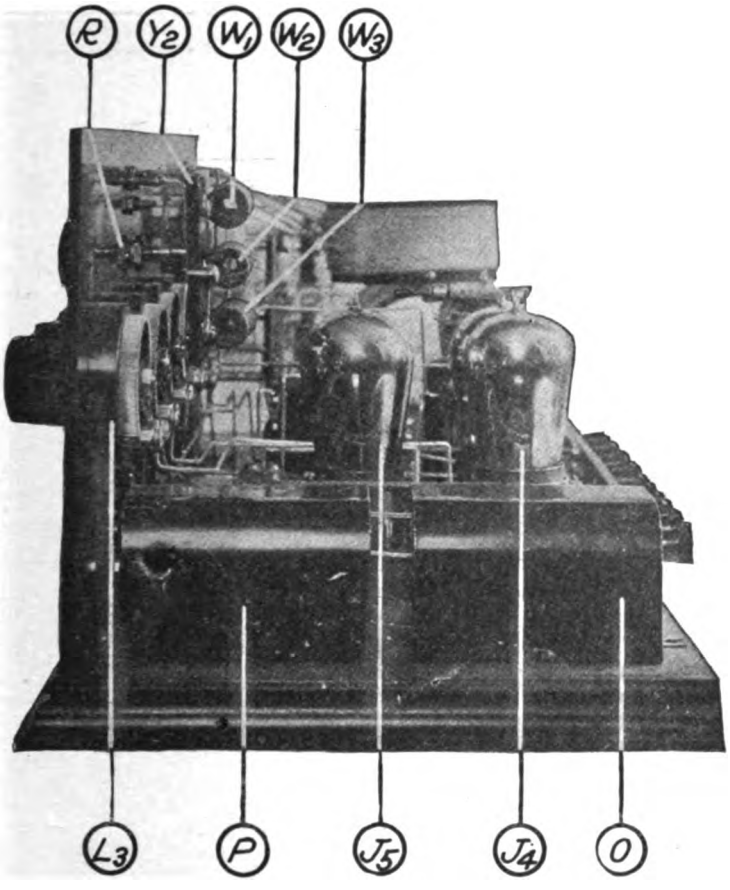

VIEW OF THE SET AS SEEN FROM THE RIGHT

FIGURE 6: *This view gives a better idea of how to mount the two push-pull transformers and the rheostats and resistances.*

nected to the detector negative "B" battery, 18 or 20 volts.

The sixth post from the right should be connected to the detector positive "B" battery, 18 or 20 volts.

The seventh post from the right should be connected to the amplifier negative "B" battery, 90 volts.

The eighth post from the right should be connected to the amplifier positive "B" battery, 90 volts.

The ninth post from the right should be connected to the negative "C" battery, 9 volts.

The tenth post from the right should be connected to the positive "C" battery, 9 volts.

The eleventh post from the right should be connected to the extra amplifier negative "B" battery, 45 volts.

The left-hand post should be connected to the extra amplifier positive "B" battery, 45 volts.

For the detector, insert one UV-200 or one C-300 vacuum tube in the first socket J1.

Insert one UV-201-a or one C-301-a tube in each of the remaining sockets J2, J3, J4, and J5.

If the telephones are to be used, the plug should be inserted in the first jack M1, and the first two tubes lighted by turning the rheostat knobs K and L1. Turn rheostat K up about three-quarters of the way. Turn rheostat L1 up about the same distance. This will allow of reception from local and distant stations with the headphones. If the DX stations should be very far away and too weak on the first stage, take the plug out of the first jack and insert it into the second jack M2. Then turn up the rheostat L2 about three-quarters of the way, and the signals will now be amplified sufficiently to allow reception without trouble. If a loudspeaker is to be used, it may be plugged into this same second jack M2, which should give sufficient volume. However, if the DX signals are not quite loud enough in this jack, the loudspeaker plug should be withdrawn and inserted into the third jack M3 and the rheostat L3 turned up nearly all of the way. This will produce plenty of volume even on stations located on the other side of the continent.

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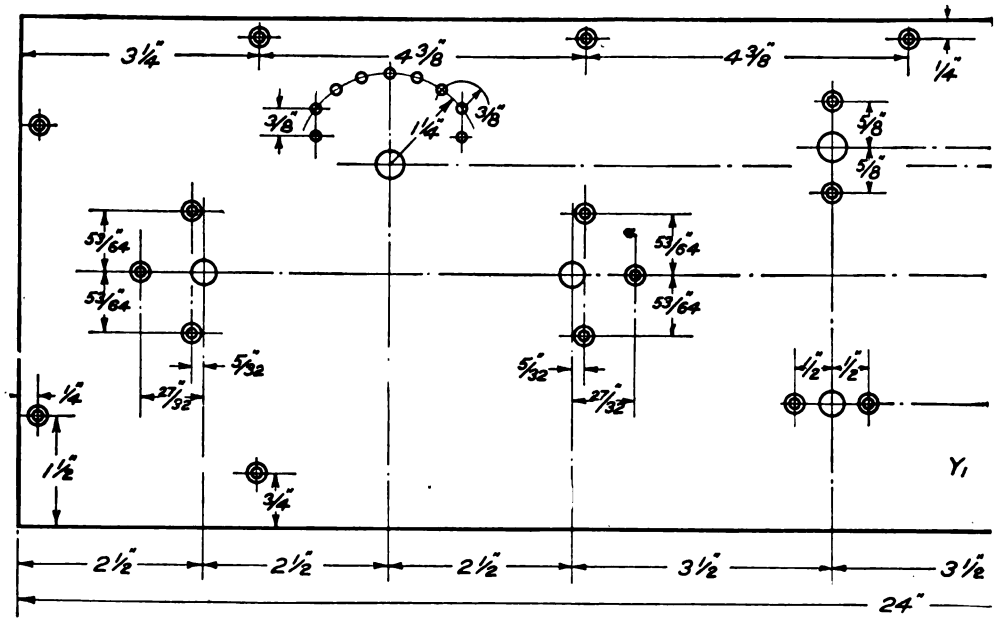

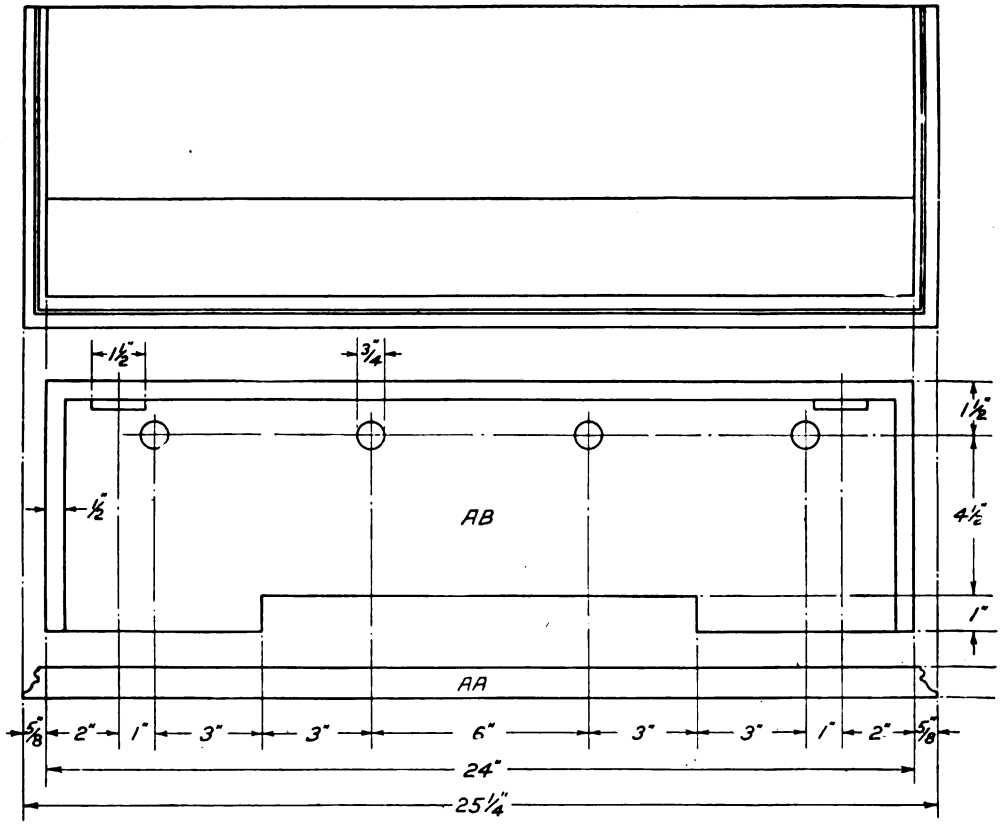

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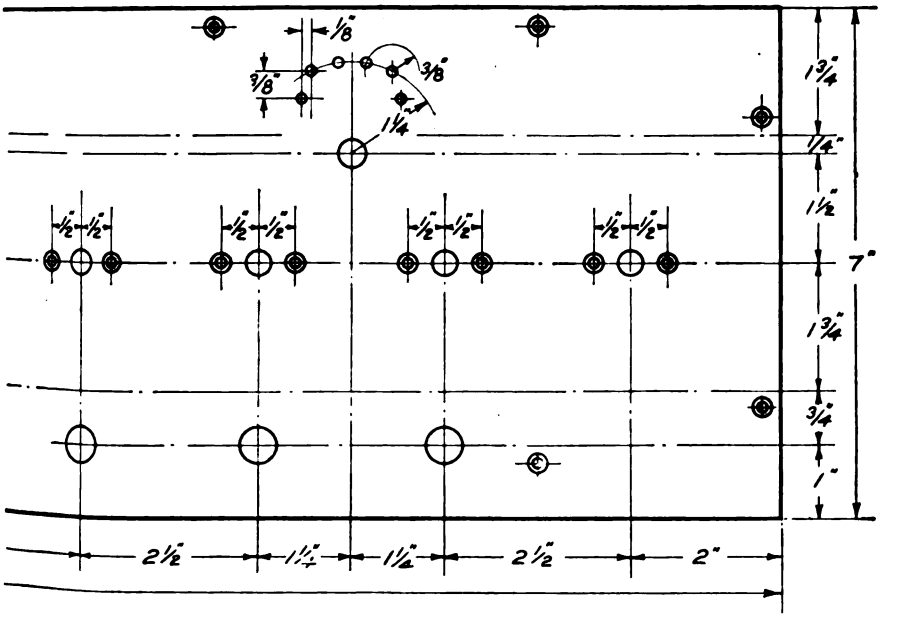


THE DRILLING PLAN FOR THE PANEL

FIGURE 7: *This drawing shows where to drill the holes for mounting the instruments. The correct spacings are given for the holes. The holes outlined with a double circle should be countersunk.*

Be sure to use a loudspeaker which is capable of handling quite considerable amounts of power, otherwise it will chatter on account of the diaphragm or armature hitting the magnets.*

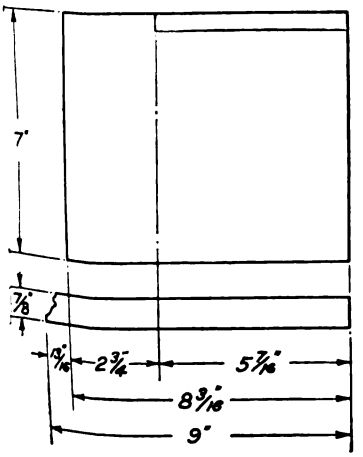
Now to put the set into actual operation: First set the two grid-densers. These are two small semi-variable condensers in which the plates are pressed together or released by a thumb-screw, increasing or decreasing the capacity. The condenser G should be set with the screw turned "all out" (counter-clockwise). The condenser H should be set the same way and generally it should be turned back about 1½ complete turns (clockwise). However, this depends on how the set is wired and what the quality of the detector tube happens to be. If the set does not oscillate enough, turn it counter-clockwise until it does. If it oscillates too much, turn it clockwise. If screwed down too far it will broaden the tuning. The correct adjustment can be found when the set has been in operation a few days.

Now refer to the tuning chart given in Figure 10. This is something new in tuning. The curve in the diagram shows how to tune the receiver for the various wavelengths used in broadcasting.

There are two scales on the chart, one, running up along the left side of the chart, is marked into degrees, 0 to 80, which corresponds to the two dial settings on the condensers E and F. The other, running across the lower side of the chart, is marked in wavelengths, 220 to 580 meters.

Pick out the wavelength of the local station

* With the power amplifier in this set, and a 10-D Western Electric loudspeaker (with the transformer removed), signals can easily be heard from the author's laboratory window, over the valley to the next hill, which is about half a mile or so away.



THE DIMENSIONS FOR THE CABINET

FIGURE 8: *This diagram (which contains the top, front, and side measurements for the walnut cabinet) may be turned over for construction to a competent cabinet maker who can build it from these directions exactly the right size for the panel.*

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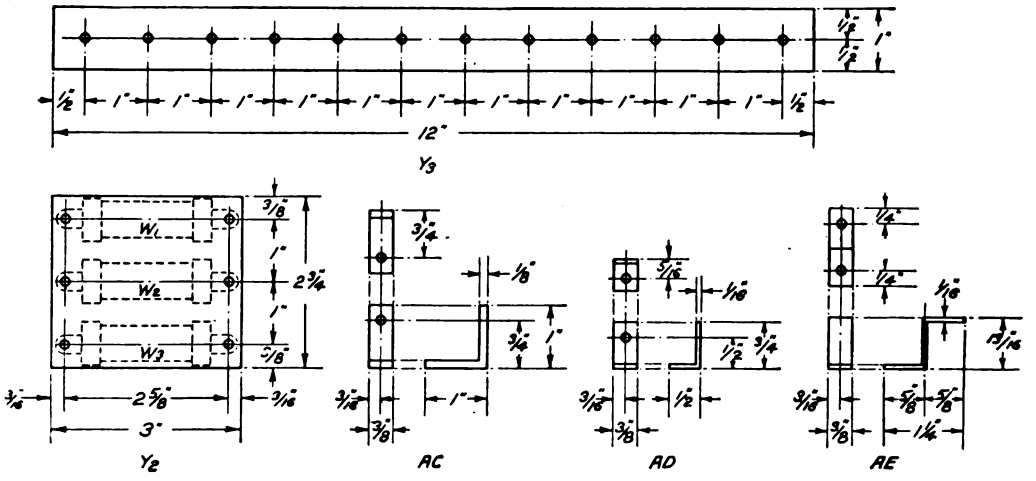
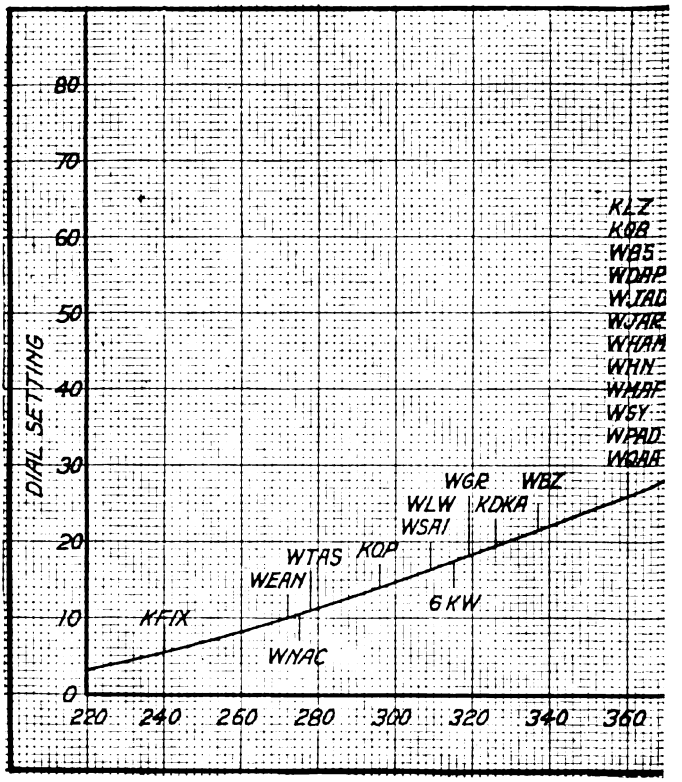


DETAILS OF THE SMALL PANELS AND BRACKETS

FIGURE 9: *This drawing gives the necessary data for making the two small panels for the connecting block and the resistances, and for making the small brass brackets for mounting the main panel, the connecting block and the coil set.*



THE AUTOMATIC TUNING CHART—

FIGURE 10: *Paste this on the lid of the cabinet. It shows you how to tune the set for a given wavelength. Pick out the vertical line corresponding to the wavelength you want (on the lower scale) and follow it until it hits the curved line. At this point*

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on the chart and follow up the vertical line which runs through this point on the chart, until it crosses the curved black line. At this point, follow the horizontal line on the chart, which crosses the same spot, until it fetches up at the left side of the chart. This will give the proper dial settings for the two condensers E and F, for that particular wavelength.

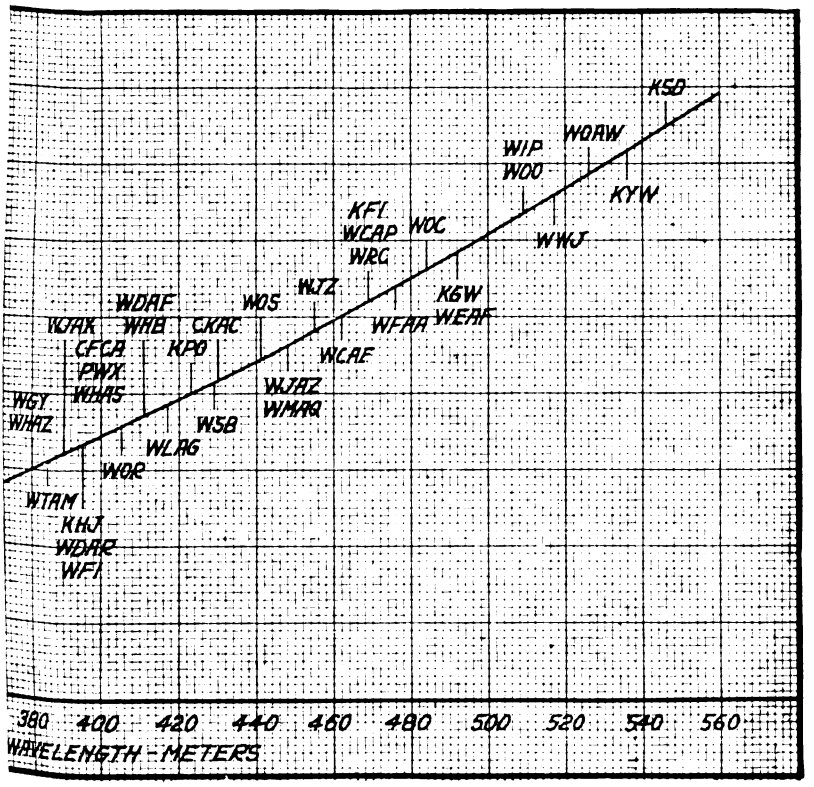
First, in tuning in a station, see that the two small vernier knobs are set so that they read horizontally, then set the two large dials at the setting found on the chart for the given wavelength. *Immediately, the station desired should be heard* (provided it is transmitting at the time). Then swing the switch lever Q to the proper point for the antenna wavelength (loudest point). Now further increase the volume by adjusting the vernier of condenser F, and finish up with condenser E's vernier. In tuning in the first station received the proper settings for the grid-leak I should be made. This will be found to be with the knob rotated somewhere near all the way out (counter-clockwise). Then the proper setting of the detector rheostat K, and the potentiometer X should be made. The potentiometer should be set about half way. Rotating the potentiometer knob clockwise increases regeneration by varying the resistance of the plate circuit and the "B" battery potential applied to the detector tube. Rotating this knob counter-clockwise decreases regeneration.

The switch R is used to control the volume output of the second and third stages of amplification; by placing the switch lever R on the first point (tap) the volume will be decreased and by swinging it to the right, point by point, the volume will be increased in steps. It is seldom necessary to use the last point to the right, even on DX.

The call letters on the chart include some of the larger broadcasting stations heard and logged by the author with this set, and probably do not include many stations that would be heard by listeners on the west coast. For these people, it would be a simple matter to write in, on the chart, some of their more familiar stations.

It is suggested that the builders of this set, cut out the chart in Figure 10 and paste it in the lid of the cabinet for ready reference. It works on all sets that use the condensers and coils specified; it works on any antenna, and it works for anybody who can read and set the dials.

The control is automatic.



—FOR PICKING UP BROADCASTING STATIONS

follow the horizontal line, intersecting the same point on the curve, and read the proper setting for both dials on the left-hand scale. Thus for station PWX the wavelength is 400 meters and the correct dial setting for the condensers E and F is 34½ and 34½

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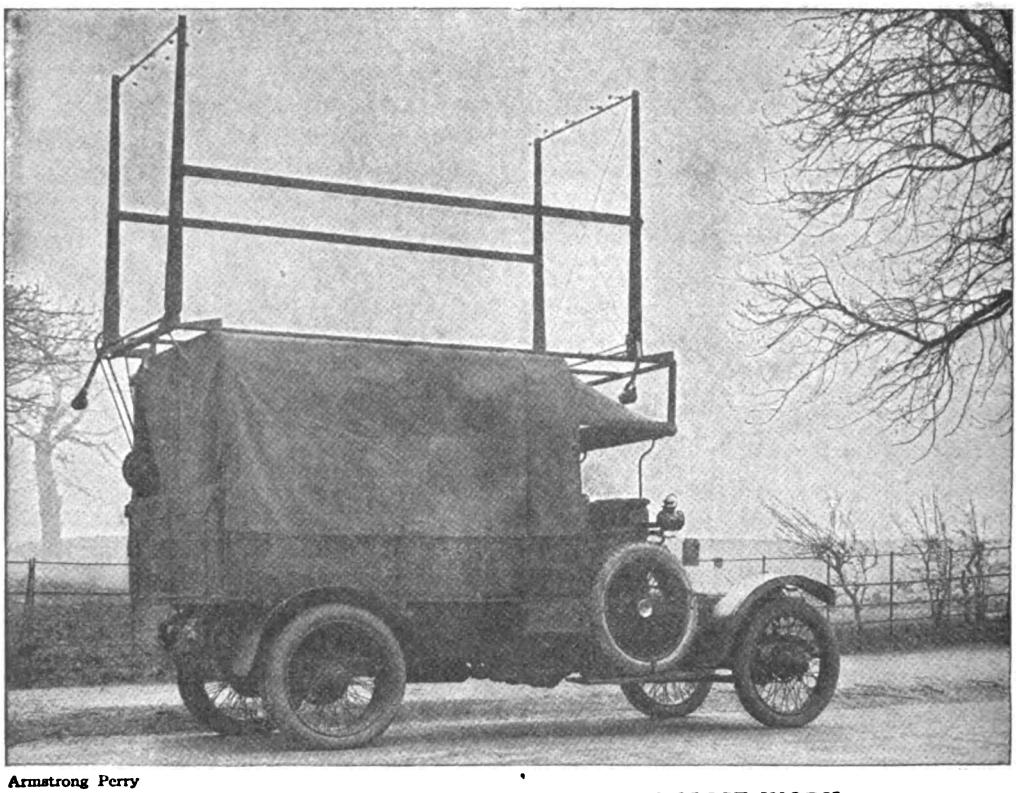
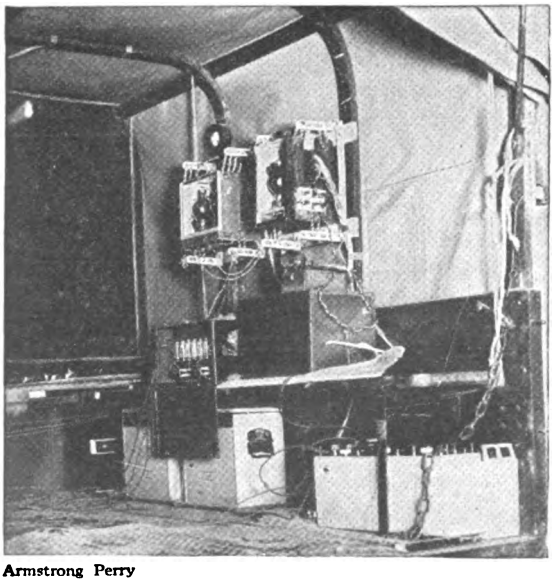


Armstrong Perry

A MOTORIZED RADIO STATION FOR POLICE WORK

This unique automobile, equipped with a powerful transmitting as well as receiving set and a collapsible antenna frame, has recently been put into service by the famous Scotland Yard officials in London. This portable radio station has been found of special value in directing crowds that assemble (for example) on such occasions as Derby Day, as it maintains a two-way communication with police headquarters.



Armstrong Perry

AN INTERIOR VIEW OF THE CAR

The transmitting and receiving radiophone apparatus is securely fastened to the side structure of the truck; it consists of two shockproof boxes, which hold the high-power, air-cooled transmitting tubes (shown here) and a small portable receiver that employs six tubes in a cabinet (at the left center); the cabinet containing the rest of the tuning apparatus for transmitting is seen at the right center and (below the shelf) is seen the high and low-tension batteries.

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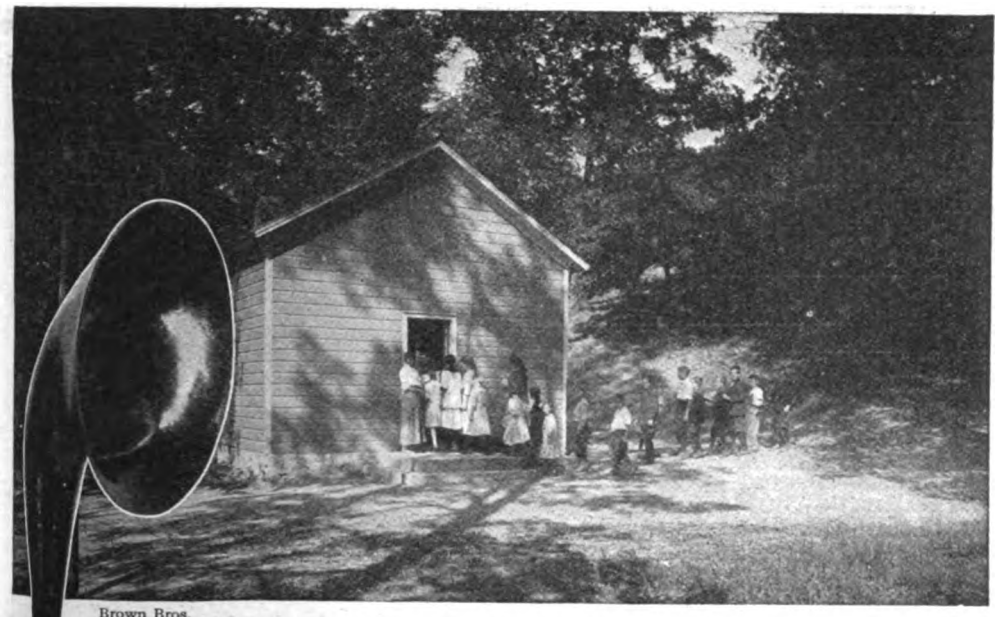

Brown Bros.

A NEW TEACHER COMES TO TOWN

The gradual extension of radio to our educational problems may literally "bring the world's greatest scientists and the world's greatest music" into the Little Red Schoolhouse sooner than the more conservative of our educators realize.

The University of the Ether

How will our educators, accustomed to plan courses of instruction in terms of the school or college only, solve the infinitely larger problem of reaching all the people of an entire state?

By PERCY MACKAYE

The author of this article is known throughout the world as a poet and dramatist of unusually vivid imaginative powers. His visualization of the future of radio in the field of education is so broad—(and so closely in accord with POPULAR RADIO's own conception of it)—as to open up an entirely new conception of what "education" really is and of the methods of imparting it.—EDITOR.

THE discovery of the uses of the ether for human communication is as revolutionary as the discoveries of Copernicus, Columbus and Darwin.

Yet we are hardly half awake to its tremendous implications.

Radio, a godlike invention, calls upon man to be as godlike in his uses of it; yet he toys with it still, like a curious groping child, not yet realizing that he has found an instrument of Phœbus Apollo that may revolutionize civilization.

Radio indeed puts upon us a supreme test of imagination. Are we humanly capable of realizing the new universe that it opens upon us with such blinding suddenness?

Fresh, divinely potential for human

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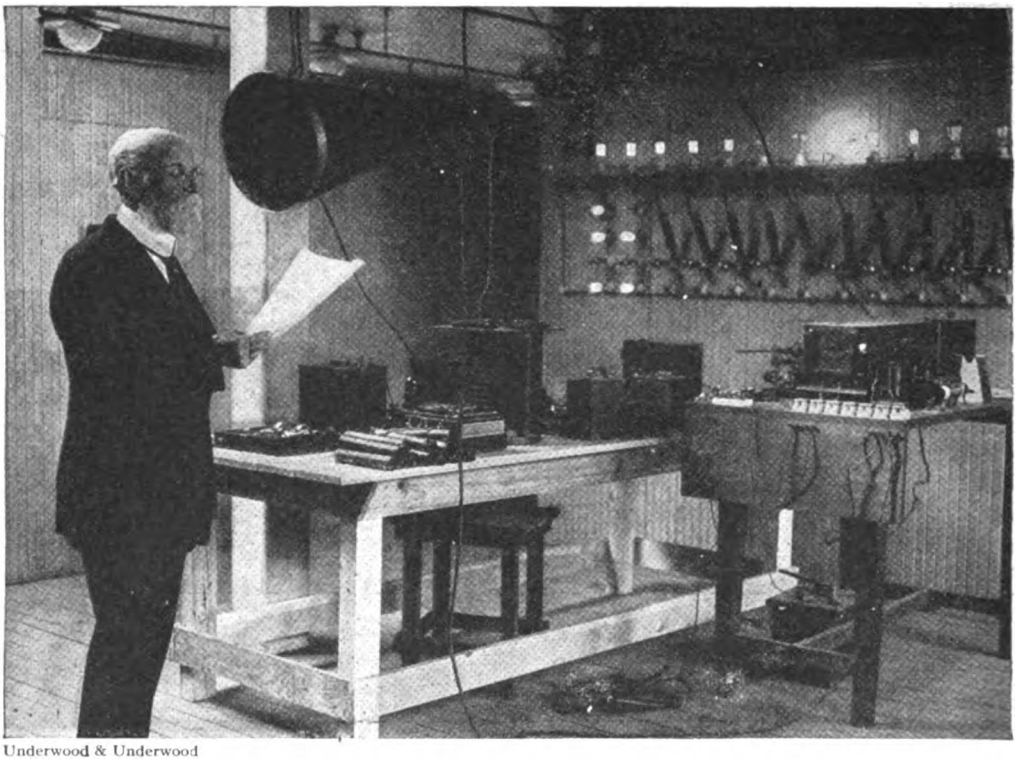

Underwood & Underwood

COLLEGE PROFESSORS WHOSE LECTURES GO INTO THE HOME

While university authorities have been slow to realize the effect that radio is destined to have on educational methods, a few colleges have begun experimenting with extension courses that are designed not for mere undergraduate groups but for the residents of entire states.

joy, communion and emancipation, is this quivering creature of the Apocalypse to be harnessed to the dreary, commercial humdrum of mediocrity which has subdued so many noble forerunners of invention to the paces of dullness and greed?

Are we to make of radio (or try to make of it) just another adjunct of the treadmill of organized education? Or will we make it the path to a regeneration of educational life—the gateway to a University of the Ether?

Hudson Maxim gives us a staggering sense of the fresh relationships and infinite magnitudes involved for us in the forces of the ether.* Are such widening relationships and magnitudes to expand our own minds to larger conceptions of the nature of education itself? Or are they to be ignored or minimized to fit the older notions of pedagogics which constitute our present entrenched and salaried system?

Fortunately for the breaking of precedents, those who are interested in radio are, from the start, an army of youthful-hearted enthusiasts, eagerly responsive to the growth of its human influences. "Faith and hope," says Coué, "are the creative forces." These enthusiasts already possess faith and hope in the powers of their new discovery—theirs by adoption, to make of it whatever they are capable of imagining.

Millions strong, they stand ready to be enlisted as charter members of a University of the Ether—provided that it meets their youthful forward-looking demands.

What are those demands?

*See POPULAR RADIO for April, 1923

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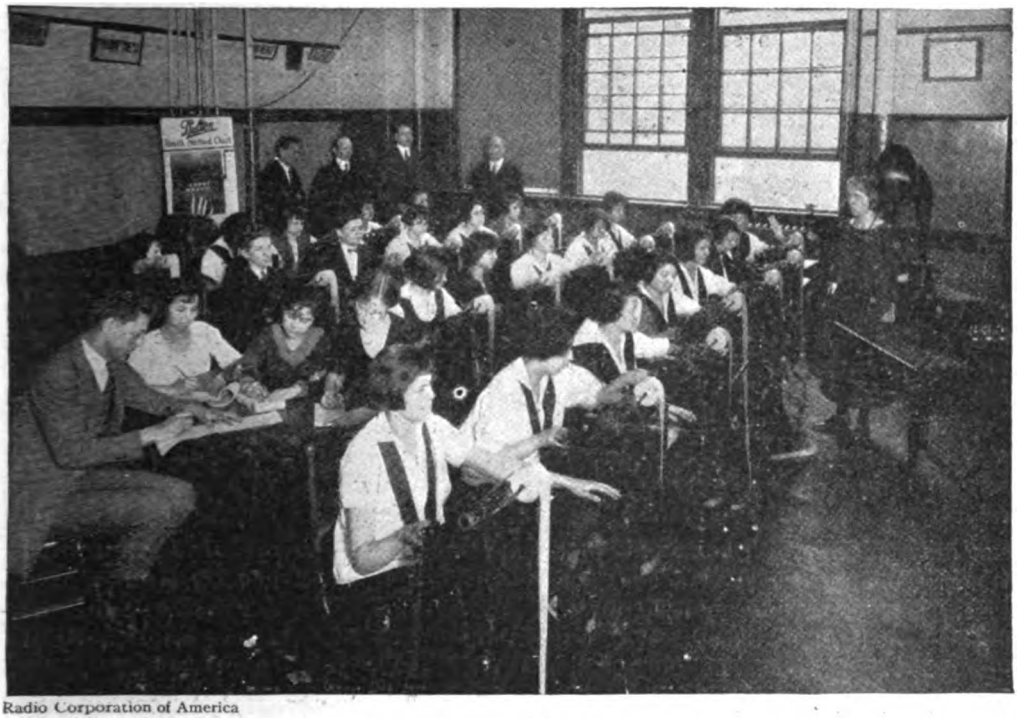

Radio Corporation of America

A PRACTICAL DEMONSTRATION OF RADIO IN THE CLASSROOM

As evidence of the possible uses of radio in schools, the Haaren High School of New York has staged, in collaboration with the local station WJZ, a series of classroom problems. Such problems and lectures may be broadcast throughout all the schools of a large area.

First of all, that the offerings of education (whatever forms of a new kind of *curricula* they may assume) shall be fascinating. Otherwise, by a mere twist of thumb and finger, pupils will dismiss their teachers to silence and the stellar spaces.

Does this conception of university discipline dismay the established conformist? Probably; and there are other conceptions more dismaying to educational precedent.

The University of the Ether will be devoid of all systems of outward discipline. It will need none, for it will be essentially a convocation of the disembodied. Each physically separate, each voluntarily self-disciplined, all of its millions of students will commune in the ether itself by virtue of the imagination of the educator.

Necessarily its doors must be open to all ages, both sexes, and to all races —and necessarily no consequent social disharmony can result. For our new higher learning there is no racial problem involved; there is no age limitation to admission; there are no examinations; there are no compulsions of any sort whatever.

In brief, this new kind of university returns to that basic principle of self-teaching which pertains to all healthful childhood—the satisfying of curiosity, attained by voluntary self-discipline. What hardy endurances have been self-imposed by childhood in order to study an ant-hill or a bee-hive! How fascinating is the pursuit of all truth until it is diverted by substituting some symbol of blame or honor, failure or success, for the truth itself!

The University of the Ether deals with a new, myriad individualism:

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by untold numbers it calls not the herd but the individual to self-culture. And it begins—as all valid education has always begun—with art.

Already radio subsists mainly through art—the art of music, the most elemental of the arts. The education of the ether must remain elemental if it is to enjoy its vast heritage of prophecy. Creative art, the enkindling element of all splendid civilization (almost totally ignored by our educational system) is necessarily the basic *sine qua non* of radio education.

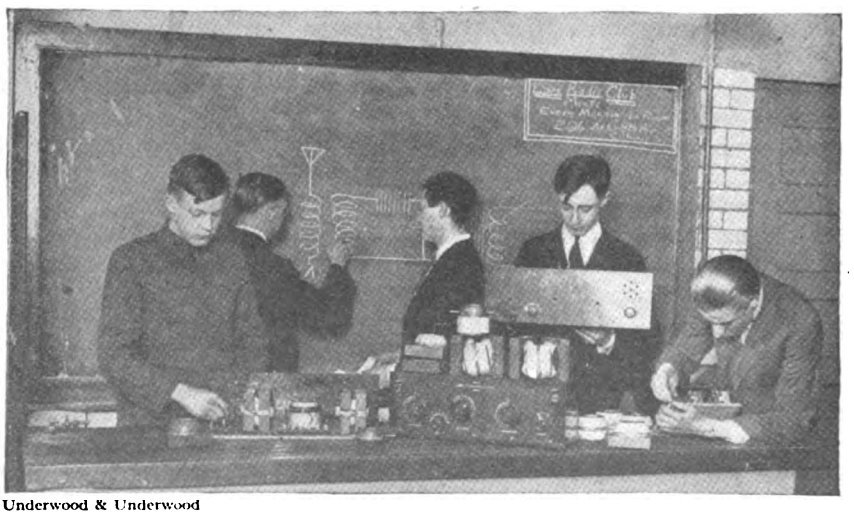
It is, therefore, by no accident that radio stations have, from the first, sought their best publicity by broadcasting the works of the world's greatest composers, through performances of symphonies and operas. Closely related to these are the works of poets and dramatists, which also are coming into wide popular demand through the ether.

Obviously the creative genius of the world, scientific and artistic, should be focused upon this vast new problem of ethereal education through some non-commercial instrumentality dedicated to the highest public service. Yet what is obvious is so seldom done that one wonders whether this shining opportunity of radio will be developed along obvious new paths unprecedented, or obstructed by blind alleys of conservatism.

The Government itself must soon recognize these new and mighty educational factors and problems. Will it place them under the static control of educational "experts," grown expert through years of experience with a system totally at variance with the ethereal principles involved? Or will it bring a fresh vision of creative art to seek a solution?

A University of the Ether! The still unfathomed powers of radio fling their challenge to the youth of the world for its noble foundation.

Some day there will rise in America some group of enthusiasts, having the requisite vision and necessary capital, who will create this education of a new order, and who will focus the creative imaginations of the world so that they may lead its millions in the fascinating pursuit of knowledge, beauty and delight.



Underwood & Underwood

SCHOOLBOYS ARE TAUGHT TO BUILD THEIR OWN SETS

Not only does the educational value lie in the programs received by radio, but ***also*** *in the manual training and technical instruction that is given in the design and construction of the apparatus. This picture shows a "radio class" in the Lane High School of Chicago.*

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700,000,000,000,000,000,000,000 Electrons for a Cent

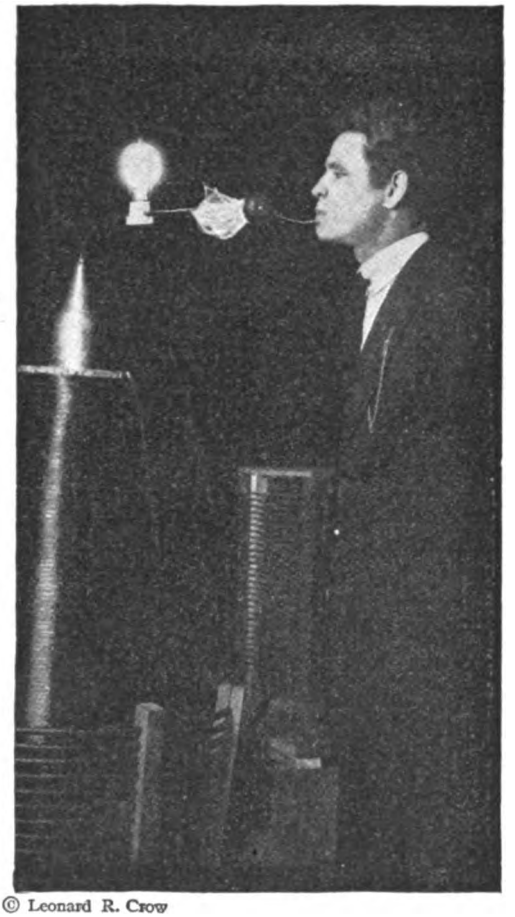
The same electrons that run the vacuum tubes used in radio also fly about in even the most solid matter. They constitute nearly all that is known about electricity. This article will give you a picturesque conception of them that you can understand.

By E. E. FREE, Ph.D.

IN spite of all the talk nowadays about electrons, there are not many people who have any clear idea of just what an electron is. It is like the Ultimate Consumer or the Average American. We have been hearing about these individuals for years, but they don't mean anything to us. We wouldn't know either of them if we saw him.

No more would most of us know an electron. We have heard the scientists say that "electrons compose all kinds of matter," which means all substances, even the substance of the human body. We know, too, that electrons constitute electricity and that as such they light our lamps and run our street cars. We know that they work the vacuum tube, that without them there would be no radio. It is electrons that produce light. Food is electrons. Fire is electrons engaged among themselves in some rather spectacular separations and recombinations. Lightning is a crowd of electrons in a great hurry. Pretty much everything that goes on in the universe has these electrons, somehow, at the bottom of it.

But just what *is* an electron? How large is it? What would it look like if we could make it large enough (or ourselves small enough) so that we could see it? Where do the electrons stay when they are not at work? How much electricity is there in one of them? Are there a million electrons in the human body or a million millions or still more than this? How many electrons can you buy for a cent?



© Leonard R. Crow

TAKING A DOSE OF ELECTRONS

Electricity enough to light a lamp can be passed through the human body safely—provided that high-frequency current is used.

These questions are by no means unanswerable. The electron is just as definite a thing, really, as an apple or a locomotive. It is possible to form just as clear a mental picture of an electron as you have now of everyday things like these.

This article is an attempt to help you do it. If you are already on speaking terms with electrons, here is where you stop. But if you are not sure you would know one if you met it, read on.

Let us begin with the scientific

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General Electric

A VAST THOROUGHFARE FOR ELECTRONS

When this lamp, the largest ever made, is lighted there pass through it every second 17,000,000,000,000,000,000 electrons. But vast as this number is it is still only about one-fortieth as many as are contained all the time inside a single copper penny.

statement that electrons compose all kinds of matter. In front of me there lies an ordinary copper cent. It is composed, of course, of one kind of matter —copper. It contains, as the scientists say, atoms of copper. It is inside these copper atoms that we must look for the electrons.

The human eye is far too coarse an instrument to see these atoms or electrons, or indeed to see inside the matter of the copper at all. But by using X rays and by various other scientific methods scientists have been able to "see" indirectly into the mass of copper, as well as into many other kinds of matter, and to explore the arrangement of the atoms and electrons.

To get an idea of what the scientists have found out, let us imagine that we possess that convenient ability of the magicians in the stories, and can make things larger or smaller just as we wish. Let us take this copper cent that I have in front of me and make it swell until it is a foot in diameter; then a mile, then a hundred miles, and so on until it is large enough to stretch all the way across the United States from New York to San Francisco. It would be, then, about 2,550 miles in diameter and the edges of it would tower 170 miles into the air, for we must imagine the cent to increase in thickness to the same degree that it increases in breadth.

If we stand now at the edge of this enlarged cent and look at it we will be able to see inside the mass of it. We would expect, of course, to see the atoms and electrons and to determine just how they are held together and arranged.

Here comes the surprise. If we really could enlarge a cent in this way, and if you and I stood side by side at the towering edge of it and peered into its interior, what we actually would see would be absolutely nothing!

By being stretched out so that it reached from New York to San Fran-

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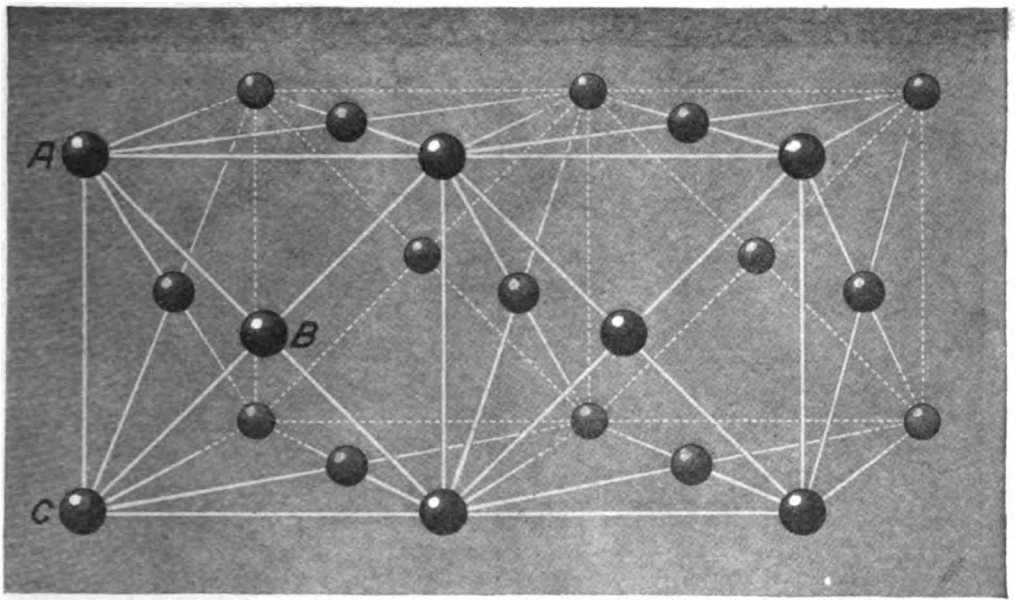

HOW THE ATOMS ARE PLACED IN METALLIC COPPER

The round balls are the atomic nuclei. If a copper penny is enlarged to cover the earth's orbit, as described in this article, these nuclei would be eleven inches in diameter. The distance from A to B would be two and a half miles, and the distance from A to C three and a half miles.

disco the copper in a cent piece would become entirely invisible.

But if instead of using our unaided eyes we got a microscope and focussed it on the inside of our enlarged penny, just as a bacteriologist focusses his microscope on the tiny germs in a drop of water, we would see what we are looking for. Every two inches or so all through the space occupied by what had been the copper we would see a little floating speck, smaller even than a grain of dust. These specks would be relatively stationary, as though they were little balls strung on invisible wires, or like the grapes in a fruit jelly; a great deal of jelly, of course, and very few grapes.

These specks are the central masses of the copper atoms, what scientists call the *atomic nuclei.* The electrons, which are still smaller, we would not be able to see at all.

In order to see them we must use our magical powers again and enlarge the cent some more. Suppose we let it swell now until it is larger than the whole earth, larger than the sun, as large, finally, as the earth's orbit. It would be, then, a great copper disk 189,000,000 miles in diameter. The sun would be at its center and the earth would be rolling, once each year, around its edge. What would the atoms and electrons inside it look like now?

The little specks that we could just see before with the help of a microscope, the nuclei of the copper atoms, would show up now as roundish things about eleven inches in diameter, like old-fashioned cannon balls or small-sized goldfish globes. And now for the first time we would see the electrons too.

These would be roundish balls, also, each about three inches in diameter, but they would not be quite spherical. Instead they are flattened a little on two sides, like a ball of soft rubber when you squeeze it between the palms of your hands. In our enlarged, earth's-orbit-sized cent the electrons would be

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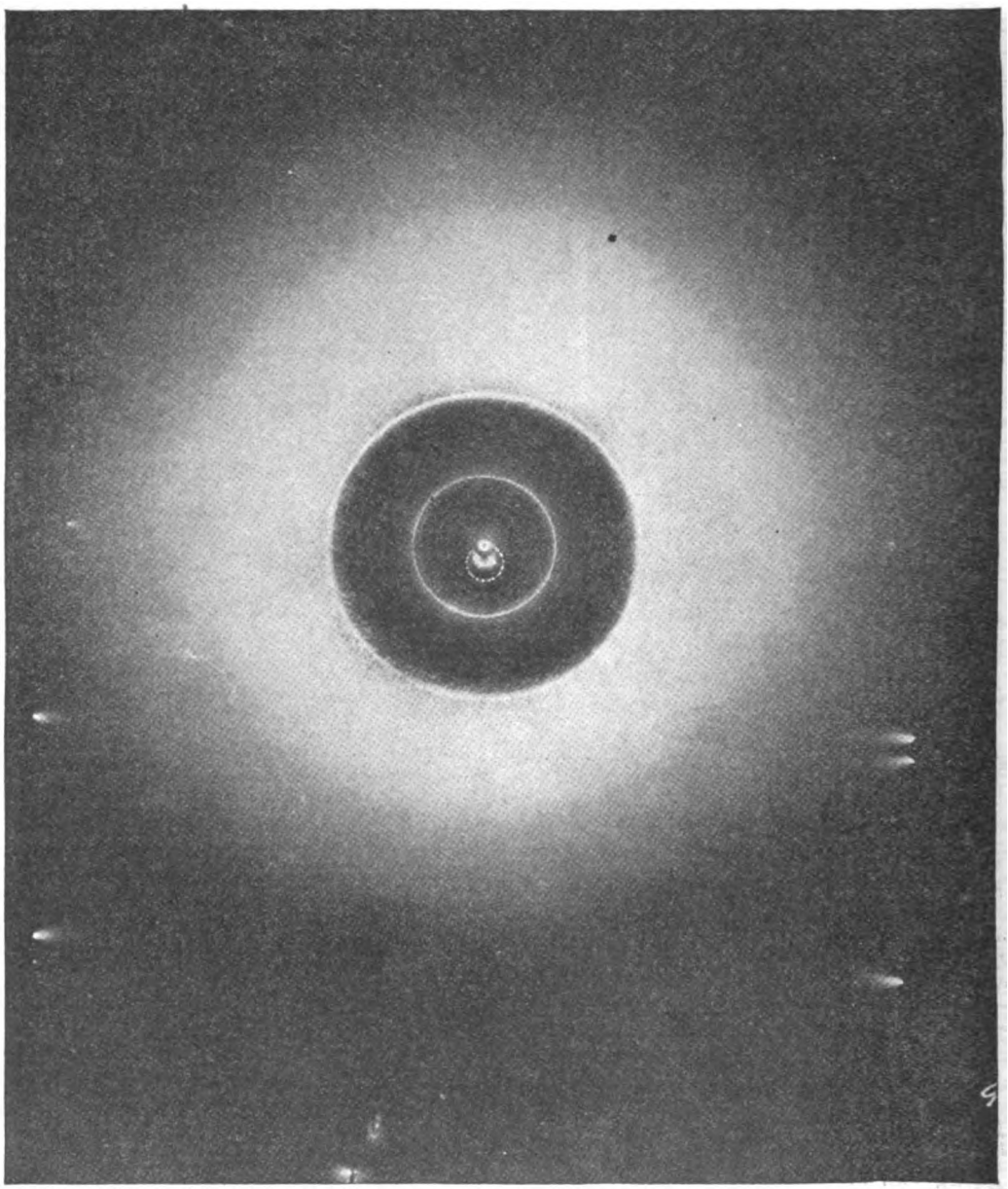

General Electric

ELECTRONS ESCAPING FROM A CHARGED WHEEL

This photograph shows a three-foot pinwheel charged to a potential of 900,000 volts. There are so many electrons on it that they crowd each other off the edge, thus making the glow that appears all around the wheel.

about the size and shape of a fairly large turnip. There would be 29 of them for each copper atom, corresponding, that is, to each one of the eleven-inch globes.

These electrons would not be still. Far from it. They would be flying about at tremendous speeds, each one in an orbit around its particular atomic nucleus much as the planets and comets

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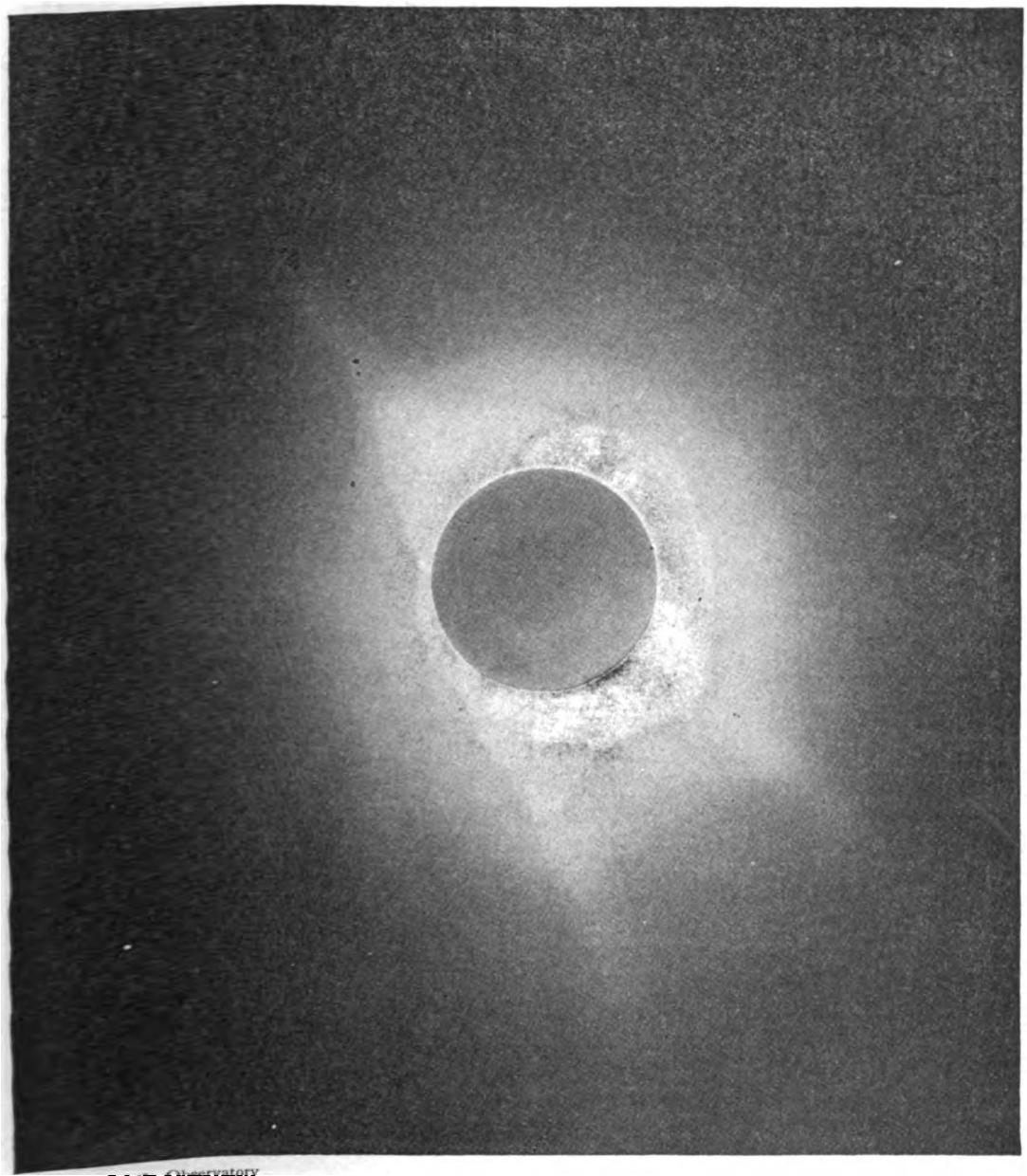

Courtesy Lick Observatory

ARE THERE ELECTRONS IN THE SUN'S CORONA?

This is the glow around the sun as it becomes visible during a total eclipse. Compare it with the electron glow on the opposite page. It is possible that the solar corona is composed in part of electrons escaping from the sun.

fly through space in their orbits around the sun.

I say that this is what we would see, but really we would need telescopic eyes in order to see all of it at once. For in this vastly enlarged cent piece the eleven-inch globes, each of them the nucleus of a copper atom, would be over *two and a half miles apart.* If you and I (keeping, of course, our

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ordinary size) were to step inside this enlarged model of a copper cent we would seem to ourselves to be in almost empty space. Close at hand we might see, perhaps, one of the globular eleven-inch nuclei. Off in the distance, two and a half miles away in each of eight directions, would be more of these eleven-inch globes. Still others would lie farther away, one after another all the way to the other side of the earth's orbit. But even the nearest ones would be quite invisible without a telescope.

In the space around us the electrons would be moving; some of them far too rapidly to be visible at all, others slowly enough, perhaps, so that we could catch a momentary glimpse of them as they whizzed by. In the two and a half mile space surrounding us in all directions, between us, that is, and the eight nearest other nuclei, there would be about 150 electrons; 29 of them revolving around the nucleus near which we are standing, the others belonging to the other nuclei off in the distance.

General Electric

A VALUABLE USE FOR ELECTRONS

In this X-ray tube it is a rapid stream of electrons impinging against the upper electrode that produces the X rays.

This is not very many electrons for so much space. About 150 little balls the size of turnips do not go far toward filling up some sixty cubic miles of emptiness. They are about as little crowded, these electrons in matter, as three very small mosquitoes would be inside the dome of the Capitol at Washington.

This is one of the most astonishing things about matter, this great emptiness of it. A copper cent seems solid to us merely because of the grossness of our senses. Really it is the openest kind of a sieve. Just as you can see with a microscope the holes between the threads of what seems to be a close-woven cloth, so if you had a microscope powerful enough you could see the holes in matter. You would see, in fact, that matter is nearly all holes. Only about two one-hundred-trillionths of the space inside a piece of copper is occupied by anything solid, by the electrons and nuclei. All the rest of the space, so far as we know, is absolutely empty.

But we are talking about electrons. Let us get back to them.

The movable electrons, the ones that fly about like planets in their orbits around the nucleus, are not the only electrons in the atom. There are some others inside the nucleus itself. The eleven-inch globe of our enlarged cent is made up in part of the three-inch turnip-shaped electrons. In the copper atom there are believed to be 15 of these internal electrons in each nucleus.

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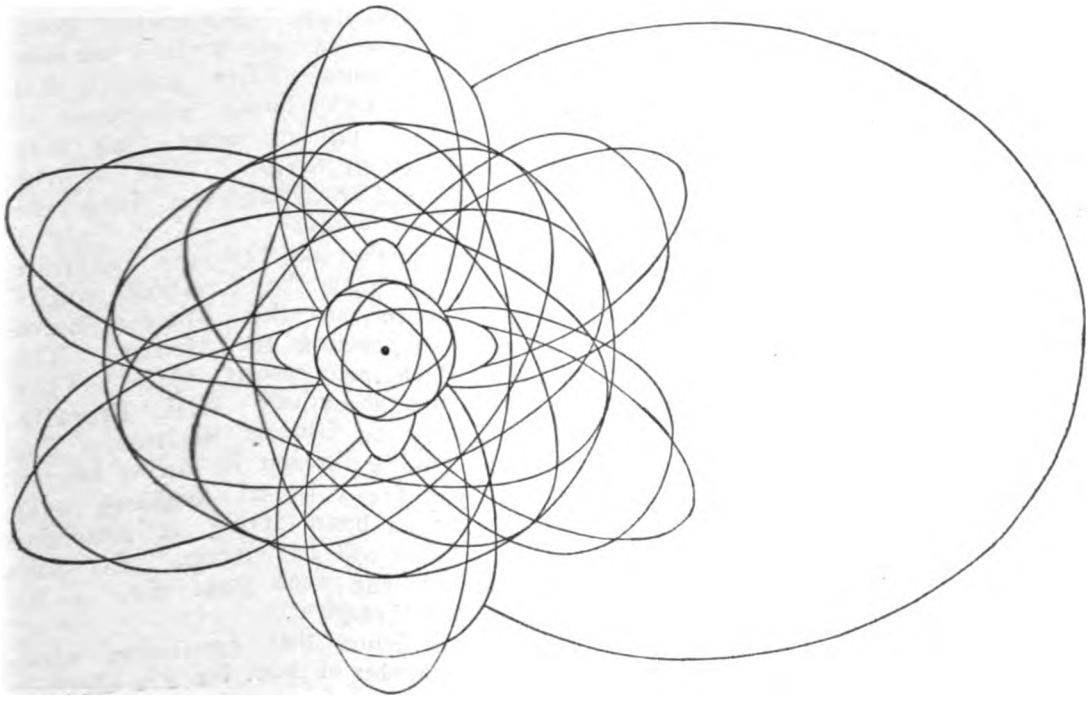

THE ELECTRON ORBITS IN A COPPER ATOM

These lines show a few of the orbits followed by the 29 electrons that revolve around the nucleus of a copper atom, as worked out by Prof. Nils Bohr of the University of Copenhagen, one of the world's greatest authorities on the structure of atoms.

They stay inside it and are a permanent part of it.

There are, then, in each copper atom a total of 44 electrons; 15 of them in the atomic nucleus and the other 29 flying about in the planetary orbits outside it. In the whole of a copper cent there are about 700,000,000,000,000,000,000,000 electrons, which is a figure so vast that it doesn't mean anything to anybody.

But think of it this way. Suppose you had to count out one by one all these electrons that are in a cent. And suppose you got all the people in the United States to help you. And then suppose that every man, woman and child took a handful of electrons out of the cent and began to count them. And suppose that everybody kept on counting them at the rate of five a second (which is a lot faster than *I* can count anything), night and day, without stopping for food or sleep. How long do you think it would take to get the job done?

Even with 120,000,000 people to help you it would take almost exactly *thirty-six million years.*

That is the number of electrons you can get, not only *for* a cent, but *in* a cent!

In larger things like a silver dollar, or a beefsteak or your own body, the number of electrons is correspondingly great. There are in the average man, for example, about 20,000 times as many electrons as there are in a copper cent. You can figure for yourself how long it would take to count them. In the ancient mythology the symbol of an impossible task was to carry water in a sieve. A much more impossible one would be to count the electrons inside yourself.

The next question that we have to

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tackle is just what this excessively tiny and still more excessively numerous electron really *is*.

The answer is that it is electricity. It is a little, flattened, turnip-shaped ball of electricity. An electric current in a wire is merely a lot of these electrons, loose ones this time, rolling along in among the attached, planetary electrons of the metal. Or "flying along" is a better simile, for the loose electrons of an electric current fly about, really, in a good deal the same way as the attached electrons do, except that they are not held fast to individual atoms and do not move in regular orbits.

To take an illustration from astronomy, these loose electrons are like the strange comets that occasionally visit our solar system and then go off about their own business into space, never to be seen again by us. The attached electrons, on the other hand, are like the soberer, stay-at-home planets of our solar system, the earth and Mars and the rest.

An electric lamp gives light because of these wandering electrons. The filament in the lamp is really a very fine metal wire. It is made up, just as our copper cent is, of a lot of atomic nuclei which are relatively quite far apart and of some electrons that move in orbits around them. Suppose, now, that you pass an electric current through this filament. This means that you drive in a lot of loose electrons at one end of the filament and that they hurry through it to get out at the other end and back again into the electric supply wires.

As they go they stir things up quite a lot. They jostle the atomic nuclei in the filament and the stay-at-home electrons that belong to them. The nuclei and electrons resent this. They get hot, not figuratively but literally. That is why the filament shines. The electrons passing through it have heated it. If you fire a lot of bullets very rapidly into a board from a machine gun the board will get warm. So does the filament wire when you fire a lot of electrons through it.

Like all figures that concern electrons, the number of them in an electric current is stupendous. Through the filament of the ordinary 60-watt electric lamp there pass each second about 3,500,000,000,000,000,000 of them. This is only about one two-hundred-thousandth as many as are held all the time inside a copper cent, but it is quite a lot just the same. It would take some time to count them even if you had help.

Keep Off the Ether During European Tests

THE *tests of transatlantic amateur communication will be held on the evenings of December 22 to January 10, inclusive. American amateurs are requested by the Amateur Radio Relay League not to transmit, but to confine their efforts to attempts to pick up the messages of their European colleagues. It asks that all American transmitters remain silent between 8.00 P.M. and 1.00 A.M., Eastern Standard Time, on the evenings mentioned; otherwise local interference may prevent the success of the tests. For Central, Mountain or Pacific Time, subtract one, two or three hours respectively from the times given. The tests will be on 180 to 220 meters. Broadcast listeners who can read code should be able to hear some of the messages.*

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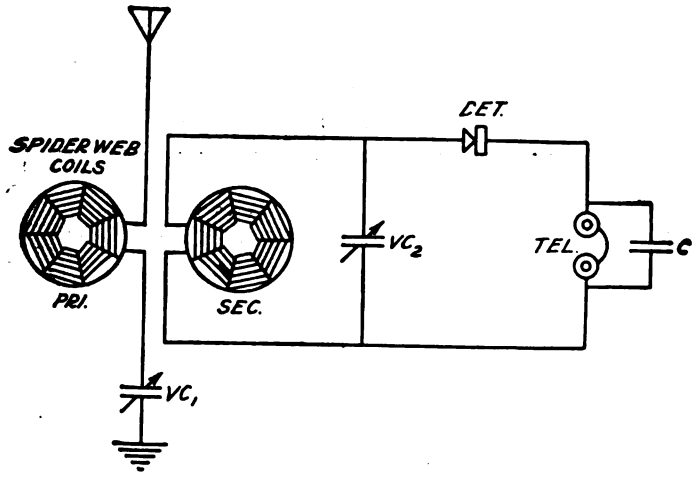

DOUBLE-CIRCUIT SPIDERWEB CRYSTAL CIRCUIT

Cost of parts: Not more than $17.00.
Selectivity: Very good.
Operation: Fairly simple. The two circuits are tuned by means of variable condensers and the coupling between the circuits is easily adjusted by swinging the two spiderweb coils nearer together or farther apart.
Ease of construction: Not complicated.
Approximate range: 15 miles.
Outstanding feature: The tuning with this type of tuner is as sharp as it is possible to get with a crystal set.

100 BEST HOOK-UPS

INSTALLMENT NO. 3

THIS feature of the magazine is designed to help the radio novice in the selection of the set best suited to his needs and to his purse. The ranges given are *averages only*; they will vary from 50 to 500 percent. The previous hook-ups of this series include:

IN NOVEMBER, 1923

The Conductively Coupled Crystal Circuit	*Range*	15 miles;	*cost*	$10.00
The Inductively Tuned Crystal Circuit	"	15 miles;	"	$15.00
The Combination Tuned-plate, Ultra-audion Circuit	"	500 miles;	"	$25.00
The Man-Day Single-control Regenerative Circuit	"	500 miles;	"	$12.00
Tuned Radio-frequency and Regenerative-detector Circuit	"	500 miles;	"	$28.00
The Squire Reflex Circuit	"	500 miles;	"	$50.00
The Reinartz Circuit, with Two Stages of Audio Amplification	"	1,500 miles;	"	$35.00
Triple-coil Honeycomb Regenerative Circuit with Two Stages of Amplification	"	1,000 miles;	"	$35.00
The Grimes Reflex Circuit	"	500 miles;	"	$40 00

IN DECEMBER, 1923

The Capacity-tuned Crystal Circuit	"	15 miles;	"	$12.00
Special Ultra-audion Circuit	"	500 miles;	"	$12.00
Single-tube and Crystal Reflex Circuit	"	1,000 miles;	"	$28.00
The Twin-variometer, Variocoupler Circuit	"	500 miles;	"	$30.00
The Triple-coil Honeycomb Regenerative Receiver with One Stage of Audio-frequency Amplification	"	800 miles;	"	$30.00
Two-tube Super-regenerative Circuit	"	1,000 miles;	"	$45.00
Modified DX Three-circuit Regenerative Receiver with Two Stages of Audio-frequency Amplification	"	1,500 miles;	"	$35.00
Transformer-coupled Radio-frequency Circuit with Vacuum-tube Detector	"	1.000 miles;	"	$35.00
Modified Acmedyne Circuit with Two Stages of Compensated Radio-frequency Amplification and Two Stages of Audio-frequency Amplification	"	2.500 miles;	"	$60.00

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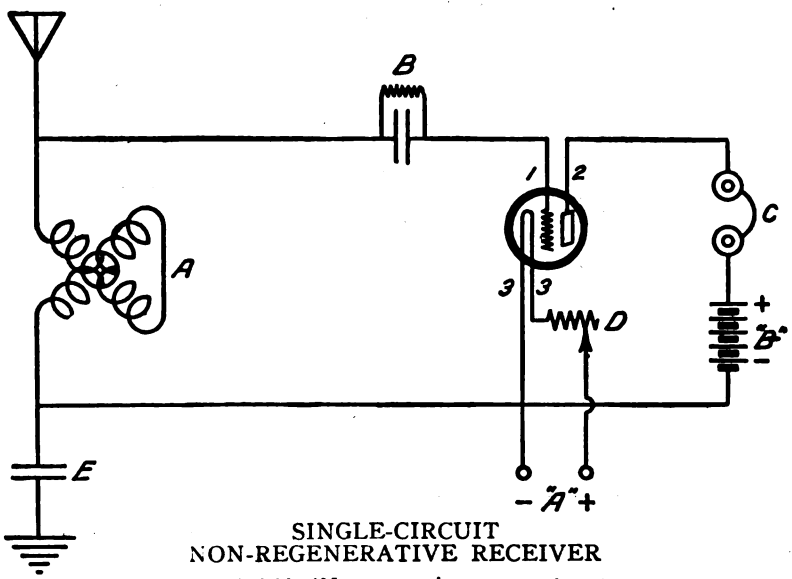
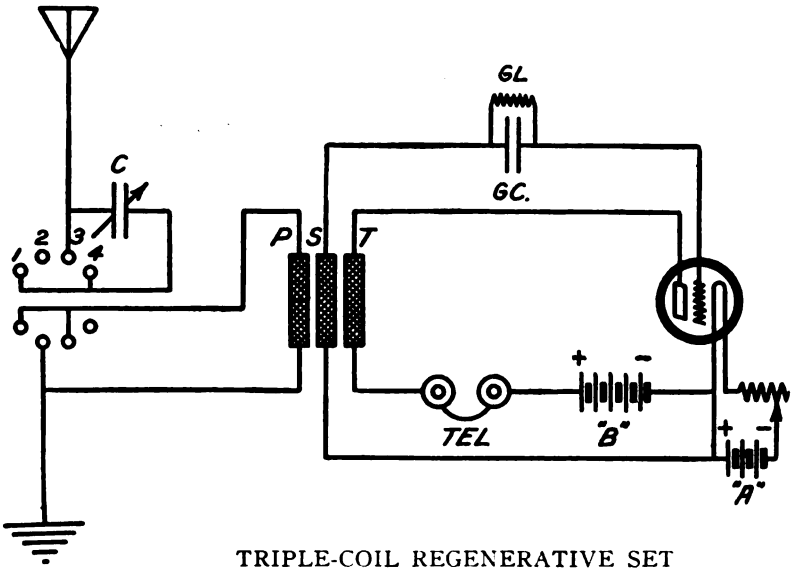


SINGLE-CIRCUIT
NON-REGENERATIVE RECEIVER

Cost of parts: Not more than $12.00 (Note: The costs of tubes and batteries are considered "extras" and are not included in the costs given in these descriptions).
Selectivity: Not especially selective.
Operation: Most simple. The variometer is the only control for tuning. The rheostat is set once for the correct filament brilliancy.
Ease of construction: Most easy to make.
Approximate range: 100 miles.
Outstanding features: The simplest vacuum-tube set to build and one that will give utmost clarity of reception (though not very strong signals). It cannot re-radiate.



TRIPLE-COIL REGENERATIVE SET

Cost of parts: Not more than $22.00.
Selectivity: Good.
Operation: Fairly simple. For more selective work, a variable condenser should be connected across the secondary coil. As shown above, the circuit is operated with coil P and coil S closely coupled together.
Ease of construction: The building of such a set is a little more difficult than the single-circuit regenerative receiver but the better results in tuning will be worth the extra trouble.
Approximate range: 500 miles.
Outstanding features: The set will tune more sharply than the single-circuit type and can be used for reception on all wavelengths by merely changing the coils; large ones are used for the higher waves and small ones for the lower wavelengths.

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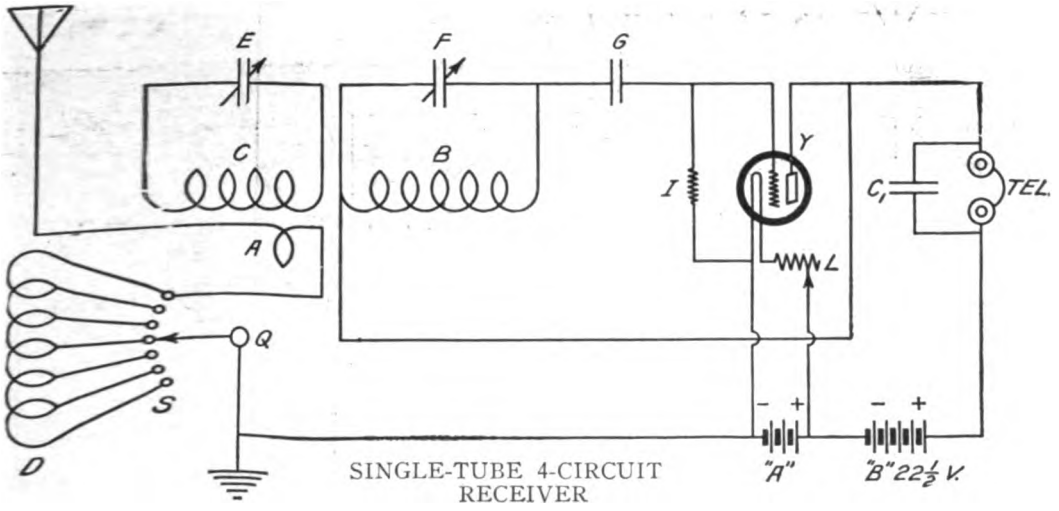
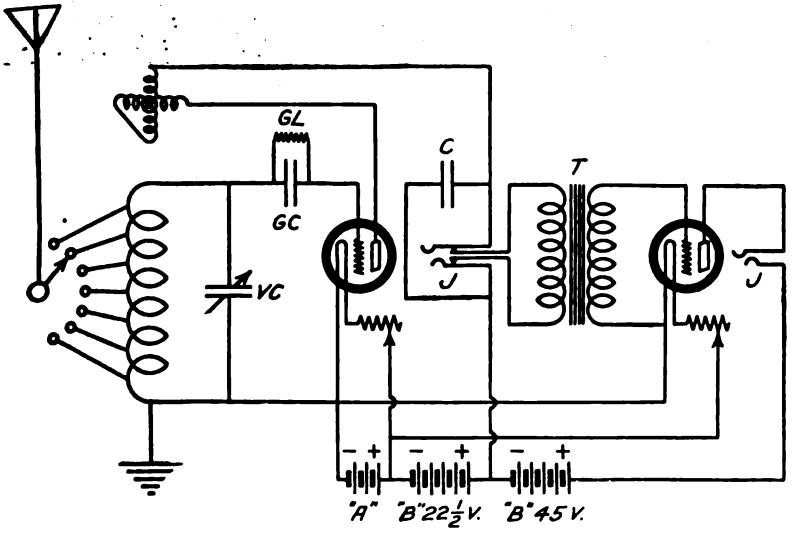


SINGLE-TUBE 4-CIRCUIT RECEIVER

Cost of parts: Not more than $24.00.
Selectivity: Excellent.
Operation: Simple. The condenser C1 should be of the correct value to put the set into stable condition and then the condenser E is adjusted so that the circuit is just on the highly regenerative point. All tuning is then accomplished with the condenser F and the antenna switch Q.

Ease of construction: Not complicated. Be sure that the best parts are obtained and the results will exceed expectations. Poor parts render the circuit useless.
Approximate range: 1,000 miles.
Outstanding features: The regeneration is independent of wavelength. The selectivity and sensitivity of this type of receiver are noteworthy.



THE CONDUCTIVELY-COUPLED, TUNED-PLATE REGENERATIVE CIRCUIT WITH ONE STAGE OF AUDIO-FREQUENCY AMPLIFICATION.

Cost of parts: Not more than $30.00
Selectivity: Fair.
Operation: Not very complicated. The antenna is tuned by means of a tapped switch, the secondary by means of a variable condenser and the regeneration is controlled by the variometer.

Ease of construction: Just an ordinary acquaintance with tools and some ability in wiring up the circuit is necessary.
Approximate range: 800 to 1,000 miles.
Outstanding features: Easy to operate and will bring in distance with good volume on a pair of telephones. Good for amateur CW reception.

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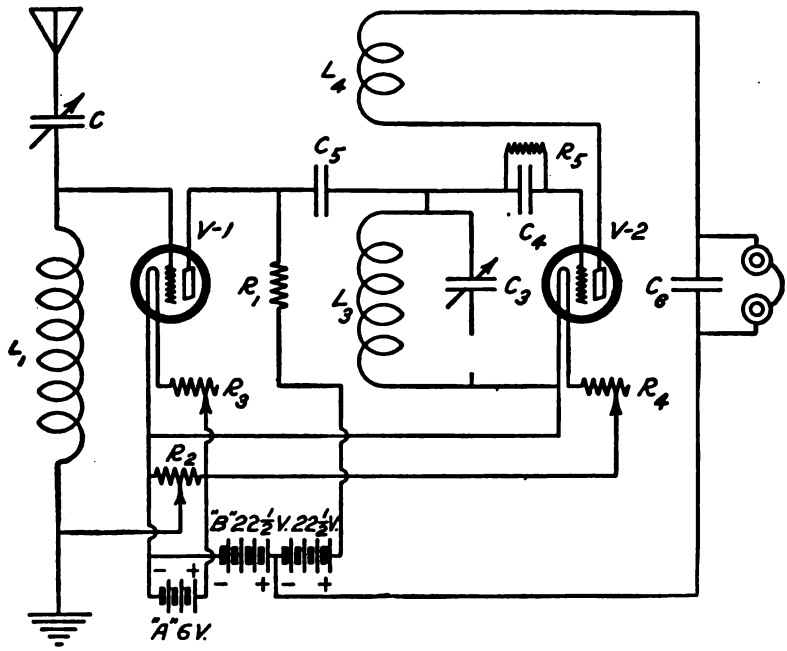
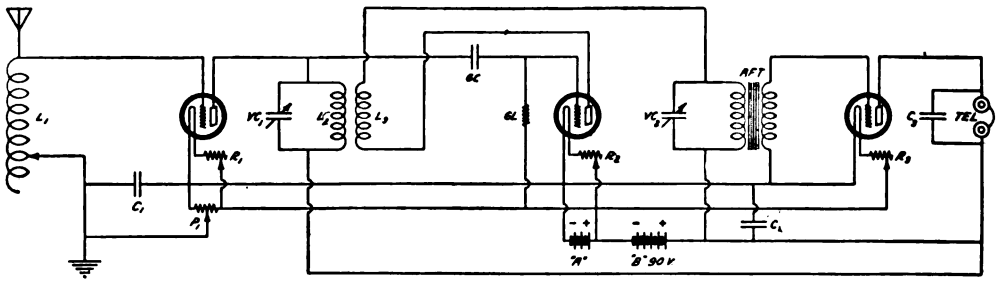


ONE STAGE OF RESISTANCE-COUPLED, RADIO-FREQUENCY AMPLIFICATION ADDED TO THE SINGLE-CIRCUIT REGENERATIVE RECEIVER

Cost of parts: Not more than $30.00
Selectivity: Good.
Operation: Not too complicated. The antenna is tuned with a variable condenser. The grid circuit of the first tube is stabilized by means of a potentiometer to prevent oscillation. The grid circuit of the second tube is tuned by a second variable condenser, and regeneration in the detector circuit is controlled by the feed-back honeycomb coil L4.
Ease of construction: Fairly complicated.
Approximate range: 800 to 1,000 miles.
Outstanding feature: The use of this type of radio-frequency amplification added before the detector tube in the single-circuit regenerator prevents this circuit from re-radiating; at the same time it increases its sensitivity and selectivity.



ENGLISH TUNED-PLATE, RADIO-FREQUENCY AMPLIFIER WITH DETECTOR AND ONE STAGE OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $35.00.
Selectivity: Excellent.
Operation: Rather complicated for a beginner.
Ease of construction: This is a difficult circuit to get going properly—but the trouble is worth while, and good results can be attained with a little patience and experimentation.
Approximate range: 1,500 to 2,000 miles.
Outstanding feature: Will not re-radiate if handled properly and is especially sensitive on weak distant signals.

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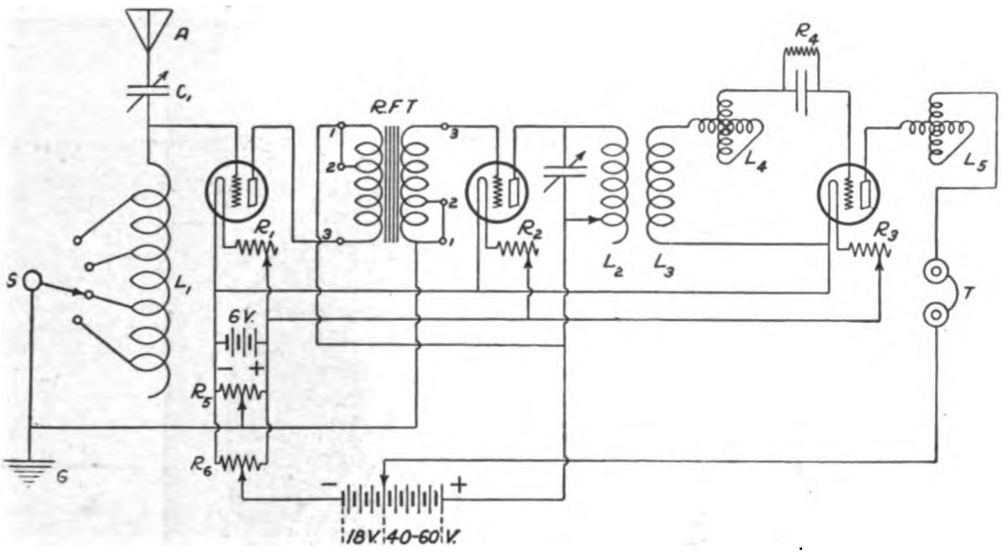
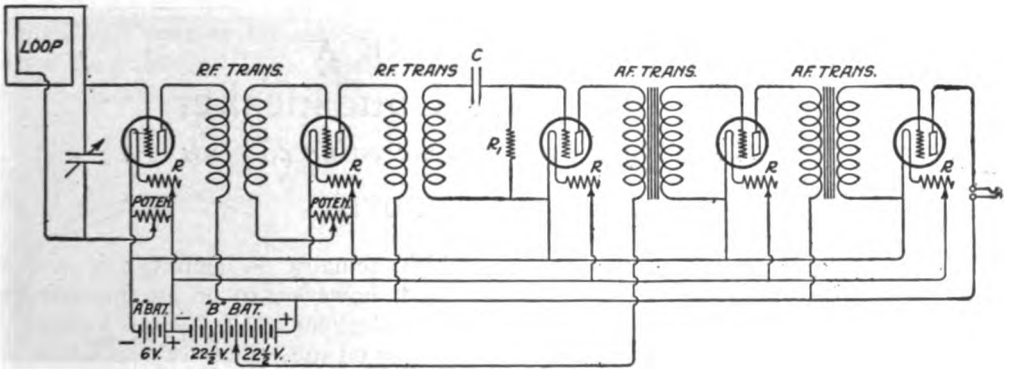


TWO STAGES OF TRANSFORMER-COUPLED, RADIO-FREQUENCY AMPLIFICATION ADDED TO THE TWIN-VARIOMETER, VARIO-COUPLER, REGENERATIVE CIRCUIT

Cost of parts: Not more than $50.00.
Selectivity: Good.
Operation: Complicated. The antenna must be tuned with the tapped switch and the variable condenser. There are two potentiometer adjustments, one for the stabilizer for the radio-frequency tubes and one for adjusting the plate potential of the detector tube. Then the output circuit of the second radio-frequency tube must be tuned with the variable condenser, and the regular tuning of the variometers in the grid and plate circuits of the detector must be done before the signal is tuned in properly.
Ease of construction: Fairly complicated.
Approximate range: 1,500 miles.
Outstanding features: Is reliable for distance reception without the audio-frequency amplification that is usually used with this detector circuit. The radio-frequency amplification brings in the distance with much greater strength without appreciably increasing the local signals.



TWO STAGES OF RADIO, DETECTOR, AND TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $50.00.
Selectivity: Good.
Operation: Simple. Only one control for tuning; the variable condenser. The two potentiometers are used as stabilizers for the control of regeneration in the radio-frequency stages.
Ease of construction: More or less complicated. There are a number of precautions that must be taken to get the circuit to function properly.
Approximate range: 500 miles (on a loop antenna).
Outstanding features: No outdoor antenna necessary and simplicity of tuning.

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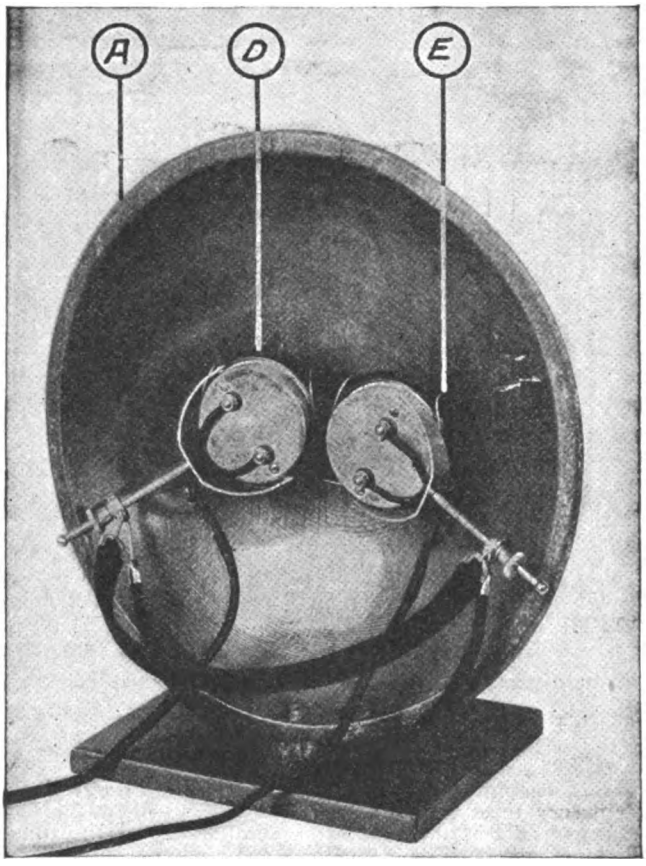

THE COMPLETED REFLECTOR

It is composed of A, an ordinary wooden chopping bowl; D, the head telephones, and E, the spring wire clips for holding the telephones.

HOW TO MAKE A
Chopping Bowl Loudspeaker
—at a cost for parts not exceeding 25 cents

By SPENCER BOYD

THE device described in this article is a loudspeaker that does not *magnify* the total sound energy from the headphones; it merely concentrates it in one direction. Devices of this kind have been called "reflectors" because they reflect the signals from the headset in much the same manner that a metallic mirror reflects light from an electric bulb. A device of this type, though, is not to be confused with loudspeakers which actually do amplify; it will be found, however, to be an improvement over telephones lying upon a table or hanging on the wall.

The reflector described here is easily made and the parts should not cost over 25 cents.

It will be seen that both of the receiving telephones of a headset may be held in place before the reflecting bowl without even removing the receivers from the

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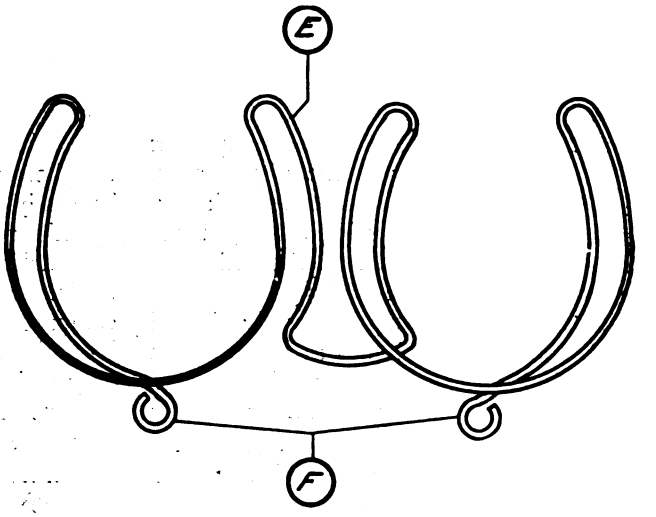


HOW TO BEND THE WIRES THAT HOLD THE BOWL

FIGURE 1: *The stiff iron wire is bent into shape as shown at the right and the two ends are bent into circular form at F, for fastening to the bowl with screws.*

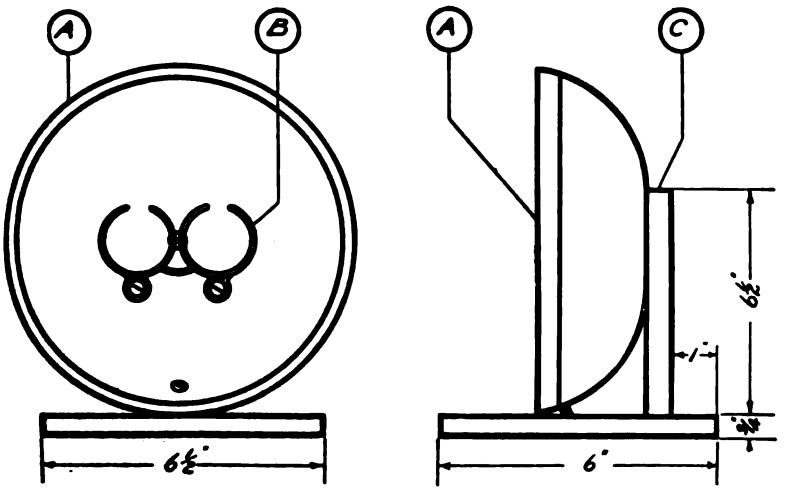
headband. This is a distinct advantage over many devices of this sort and also furnishes increased volume, because *both telephones* are used at once.

The Parts That are Needed

1 wooden chopping bowl about 2½ inches deep and 10 inches in diameter;
1 piece ½-inch wood 6½ inches by 6 inches;
1 piece ½-inch wood 1 inch by 6½ inches;
3 feet of stiff iron wire, about No. 16;
2 ¾-inch flat-head screws;
2 ⅜-inch flat-head screws;
1 1-inch flat head screw.

The chopping bowl may be procured from a hardware or ten-cent store; this forms the reflector. If the bowl is found to be impregnated with paraffin this should be removed by washing with gasoline. The large piece of wood forms the base of the reflector; the smaller piece is used as a support for the bowl.

Finish off the wooden parts with sandpaper and then assemble them. The support is fastened to the base (see Figure 2) by means of the one-inch screw, which passes up through the base into the lower end of the support. The bowl is fastened by one screw passing through its center into the support and one screw passing through its lower edge into the base. When the parts are assembled they may be stained and then given a coat of shellac, or they may be waxed.



HOW TO BUILD THE BASE

FIGURE 2: *The bowl A, is fastened to the upright piece of wood C, and the base by ordinary wood-screws. The method of fastening the telephone supporting assembly is shown at B.*

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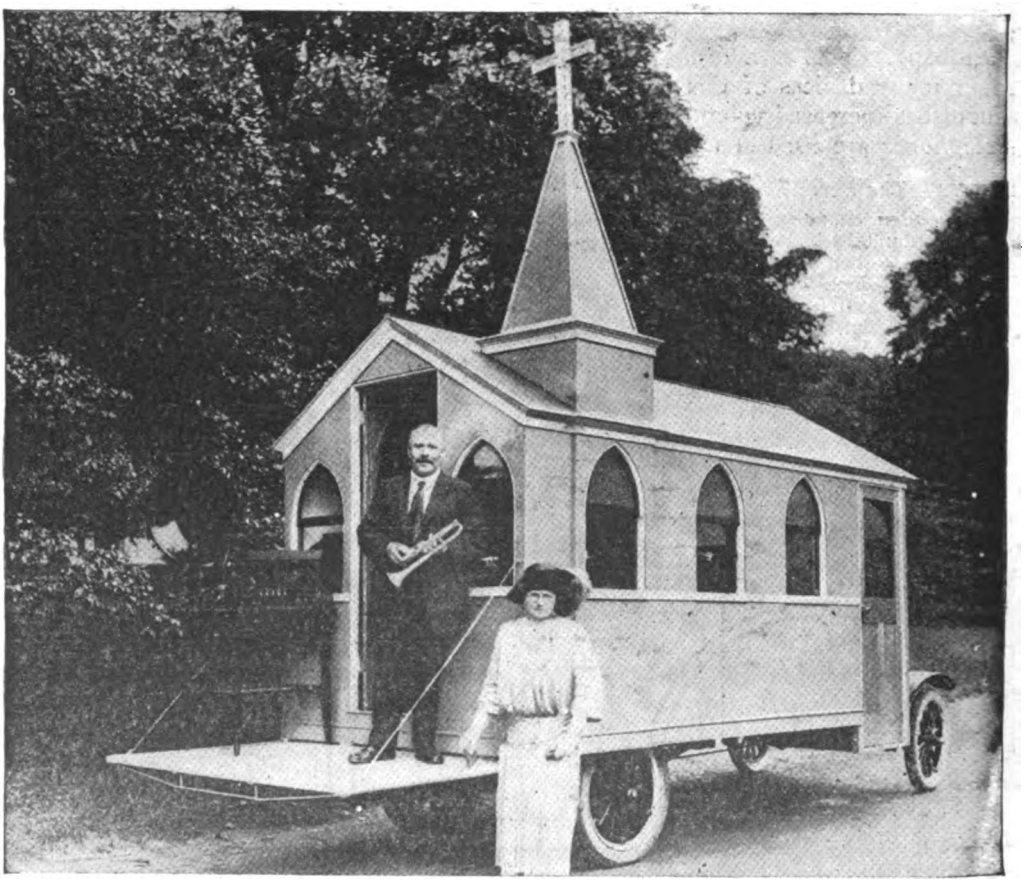
The stiff iron wire may be procured from a large hardware store. This wire is bent as shown in Figure 1, and forms a holder for the telephones. The two large loops of wire hold the telephones firmly by the rims of the phone caps. Each end of the wire is twisted into a small loop: screws passing through these loops secure the holder to the reflecting bowl.

The holder should be so adjusted that when the telephones are inserted in it (facing the bowl) they will be held securely ¼-inch away from the reflecting surface.

In use, the telephones may be either taken from the headband and left in the holder, or left in the headband and slipped in and out of the holder at will. The stiff iron wire will always hold the telephones firmly and yet permit them to be easily taken out.

This reflector has been tried out in comparison with several loudspeaking devices, costing up to $15, and has been compared favorably with all of them. Keep in mind, however, that this device only *reflects* the sound of the headset, so be sure to use a good, loudspeaking pair of phones.



Gilliams Service

THE FIRST "RADIO CHURCH"

In conservative old Boston this unusual little chapel, mounted on a motor car and equipped with a radio receiver and loudspeaker, has been operating for several months. This chapel is conducted by William H. Morgan and his wife, who drive the vehicle through the streets, stop at strategic corners—and assemble crowds by tuning in on a broadcast program.

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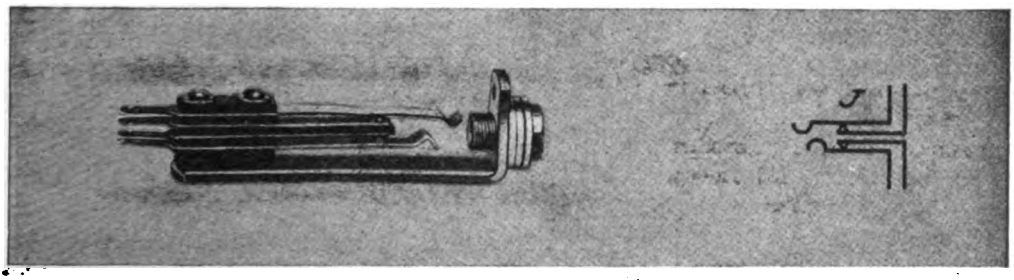
HOW TO
READ A DIAGRAM

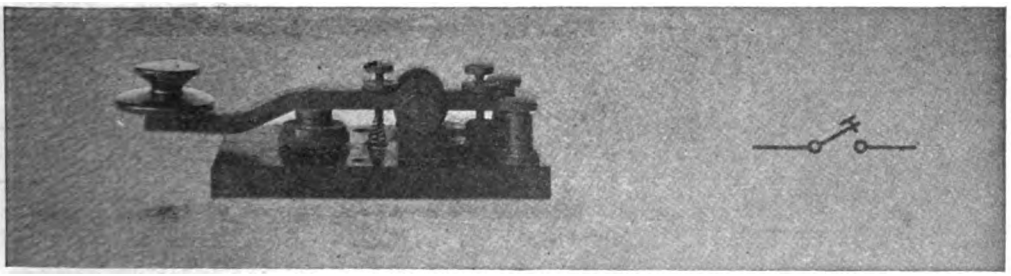
PART II

Every radio fan should be familiar with the common symbols used in the diagrams of radio circuits. They are few in number, and a knowledge of them is necessary to the understanding of hook-up drawings. This two-part article has been carefully prepared for the special benefit of the beginner in radio; it shows both the apparatus and the symbol that identifies it. KEEP THIS ARTICLE FOR REFERENCE!

By ALBERT G. CRAIG



TELEPHONE JACK—The telephone jack gives us a means of using either the detector, or one or more stages of amplification at will. The ordinary jack for all but the last stage of amplification has four terminals; the two outside terminals are connected in series in the plate circuit of the preceding tube, that is, one to the "B" battery positive and one to the plate of the tube; the two inside terminals are connected to the primary of the following amplifying transformer. When the plug is not inserted in the jack, the plate wire should make contact with the terminal marked P on the transformer and the "B" battery wire should make contact with the terminal B on the transformer, through the fingers of the jack. The last jack has two terminals and these are connected in series in the plate circuit of the preceding tube. The jack furnishes a convenient method for "plugging in" the headphones.



KEY—The key is used for breaking up the high-frequency current into dots and dashes for radio telegraphy. In the old-time spark transmitters the keys were very ponderous and unwieldy due to the fact that they had to handle (directly) very large currents, being inserted in series with the primary circuit of the power transformer. However, with continuous-wave apparatus there are places where ever. a small key may be inserted so that it will control the energy from several large vacuum tubes. There are always two connections to the key, these being shown by the two wires running to it in the diagram.

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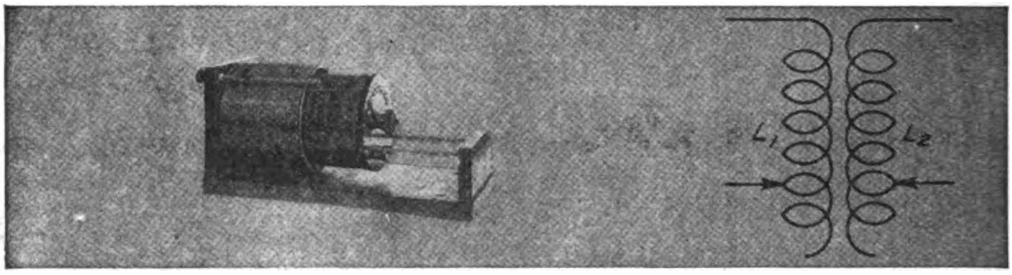
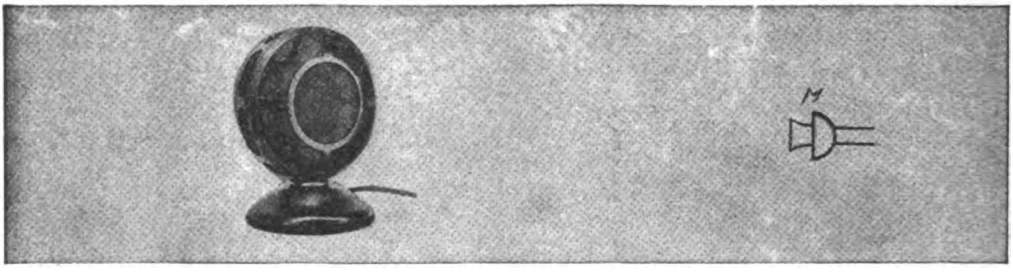
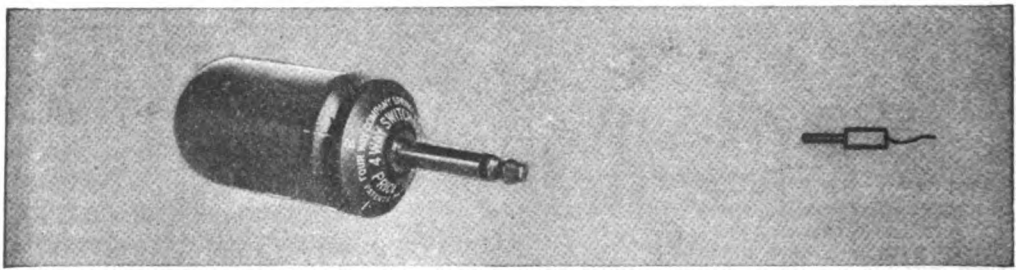


LOOSE COUPLER—The loose coupler is an older and less convenient device than the variocoupler, for coupling the primary and secondary circuits. The primary coil is stationary and is usually provided with a slider for varying the inductance by single turns. The secondary coil slides in and out of the primary to vary the coupling, and is provided with approximately half a dozen switch points to change its inductance value. There are two primary connections, one to the slider and one to one end of the coil. Also there are two secondary connections, one to the switch arm and one to one end of the coil. The construction of the loose coupler makes it inconvenient for panel mounting and it has gradually fallen into disuse.



MICROPHONE—The ordinary carbon-grain microphone consists of two metal plates with a number of carbon grains between them. These two plates form the two connections to the microphone, and they are insulated from each other, of course, except through the path furnished by the carbon grains. To one of the plates the diaphragm of the microphone is attached and the varying pressure of the diaphragm (caused by the sound waves) is transferred to the carbon grains. This changes the resistance of the microphone and consequently the amount of current which is flowing through it, so that the amount of current at any instant is representative of the sound wave striking the diaphragm at that time.



TELEPHONE PLUG—In connection with a jack, the telephone plug may be used to insert any given pair of telephones or any loudspeaker in the set instantly. There are two connections to the plug, one to the tip and one to the sleeve, and the two terminals of the telephones or the loudspeaker are merely joined to these. When a two-circuit jack is in the normal position, without the plug inserted, each outside spring makes contact with the corresponding inside spring and the circuit is completed through the following transformer. When the plug is inserted, contact between the outside and inside springs is broken, and the tip and sleeve of the plug make contact with the outside springs of the jack, completing the circuit through the telephones. This places the telephones in the plate circuit of the preceding tube and disconnects the succeeding stages from the telephones and other stages of amplification.

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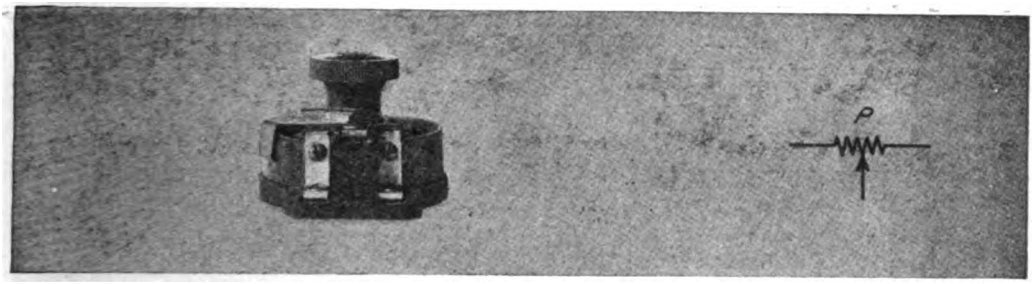
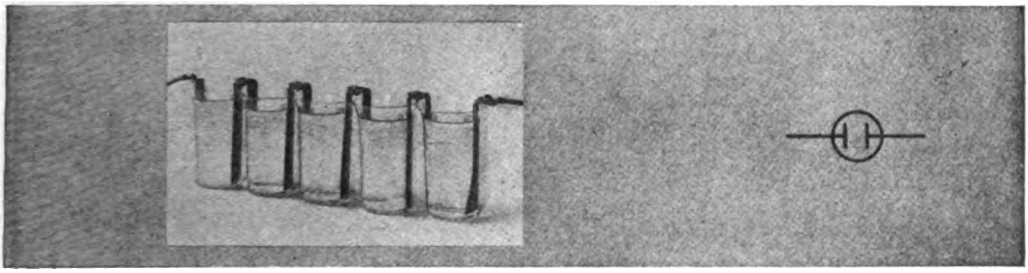
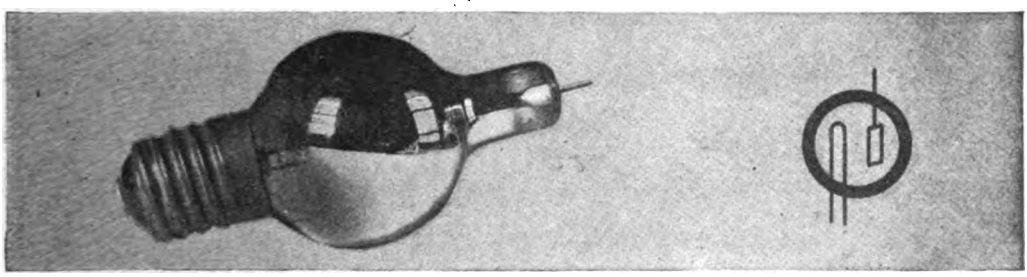


POTENTIOMETER—The theory of the potentiometer is based on the fact that the potential or voltage of a wire varies uniformly along its length from negative to positive, and that by tapping off at various points along the wire or resistance we can get any desired potential within the range of the battery. The two outside terminals of the potentiometer (ends of the winding) are connected across the "A" battery and the desired potential is obtained by moving the third connection (the pointer) to different points from negative to positive. There are two principal uses for the potentiometer, the first being to vary the plate potential of a soft detector tube by connecting the negative "B" battery lead to the pointer of the potentiometer, and the second to vary the grid potential of radio-frequency amplifying tubes by connecting the grid return to the pointer. This allows a six-volt variation in either position.



CHEMICAL RECTIFIER—The chemical rectifier cell usually consists of one lead and one aluminum electrode immersed in a saturated borax solution. For battery charging, two to four cells having large electrodes may be connected in parallel in order to carry the heavy current. On the other hand for rectifying the plate current for vacuum tubes, a number of cells that have smaller electrodes are connected in series, as the voltage is high and the current is low. The chemical rectifier is not very economical for battery charging as most often used, due to the fact that the current is most always cut down by a rheostat and a large part of the energy is lost *in* the rheostat in the form of heat. There are two connections to the rectifier, one to the positive aluminum electrode and one to the negative lead electrode.



RECTIFIER TUBE—The rectifier tube is a two-element tube and will always have three terminals. Two of these are for lighting the filament and the third is the plate terminal of the tube. The filament-lighting circuit is merely an auxiliary circuit; the connections of the rectifying circuit proper are to one of the filament terminals and the plate terminal of the rectifier tube. The source of current to be rectified is connected in series with the rectifier tube; since the current can only pass from the plate to the hot filament, the filament is always the positive pole and the plate the negative pole of the rectifier. Rectifiers range from the Tungar type (a low-voltage, high-current tube for battery charging) to the high-voltage rectifiers handling several thousand volts for the plate supply of large vacuum tubes that are used in transoceanic high-power telegraph transmitters.

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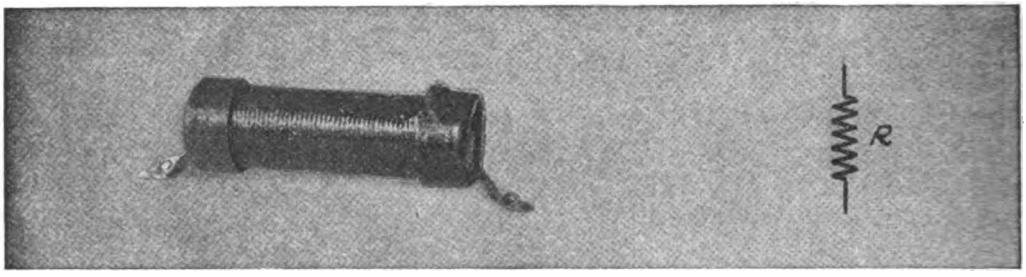
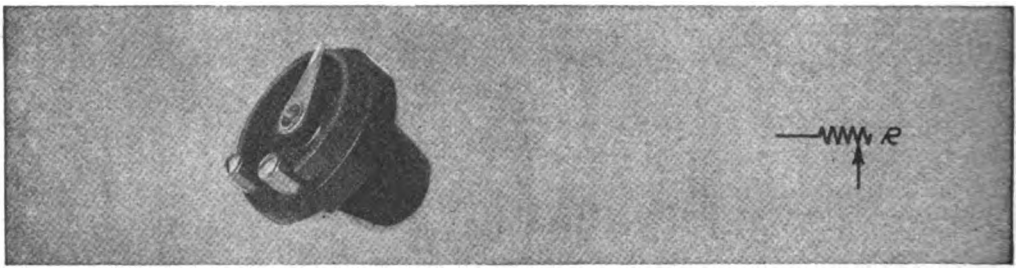
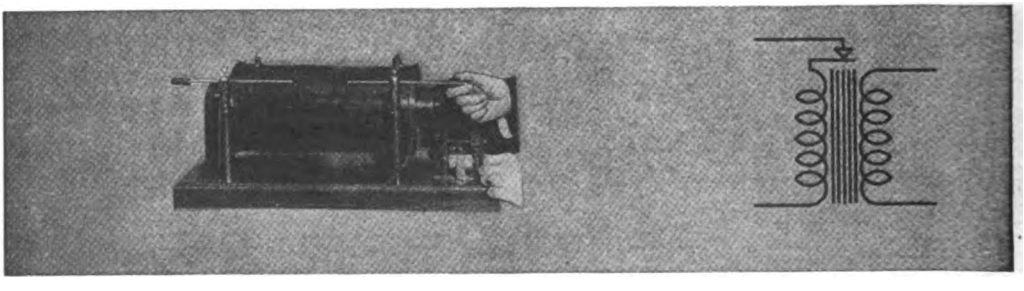


FIXED RESISTANCE—The fixed resistance can be used to couple amplifier circuits together, being placed in the plate circuit of one tube and the voltage drop across it used to operate the succeeding tube. Resistance coupling is not economical because a large quantity of the plate-circuit energy is lost in the resistance in the form of heat. On the other hand it has the advantage of amplifying nearly all frequencies used in radio *uniformly*, and thus does not give distorted signals. The fixed resistance has two terminals, one at each end of the resistance element. The element may take the form of a continuous winding of wire or may be made up of some high-resistance material such as carbon or graphite. It should generally be non-inductive; in some circuits this is imperative but in others it doesn't matter.



RHEOSTAT — As the voltage of a battery gradually decreases with use, all tubes are designed to operate at a voltage somewhat less than that of the battery they are to be used with. The rheostat should, therefore, have sufficient resistance to cut the battery voltage down to the proper tube rating. Also the current-carrying capacity of the rheostat should be large enough to prevent undue heating; for instance, an ordinary commercial 50-ohm rheostat would burn out immediately if used with a tube drawing one ampere or more. However, do not worry if the rheostat heats up to a certain extent, as that is the way the energy lost in it is dissipated. The rheostat has two connections, one to the pointer and one to one end of the winding. Use a rheostat with your tubes of the resistance specified by the manufacturer.



SPARK COIL — The spark coil is an instrument used to obtain a voltage high enough to jump a specified air gap, the discharge across the gap being used to send out waves at a radio frequency. The primary consists of a small number of turns and the secondary of many turns of fine wire, both being wound about a laminated iron core. A method of interrupting the primary circuit at regular intervals is provided, and this interruption gives us an alternating secondary current of very high voltage. This current is used to charge a condenser until the voltage is sufficient to break down the air of the spark gap and discharge across the gap. Generally there are four connections to the spark coil, two to the primary and two to the secondary. The interrupter is usually made integral with the coil and placed in the primary circuit. However, the interrupter may be separate if connected properly in the circuit.

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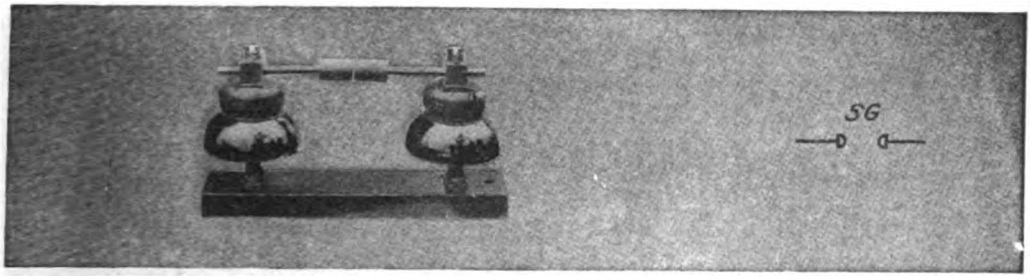
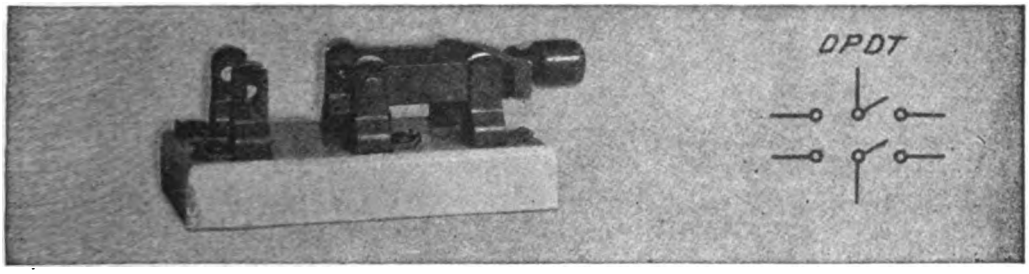
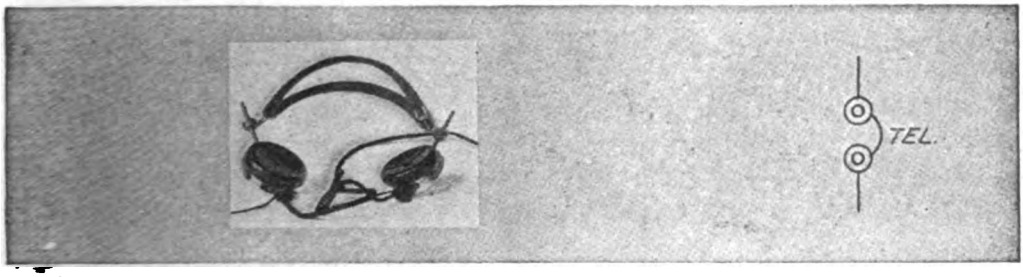


SPARK GAP—For any form of spark transmitter, some kind of spark gap must be provided. This is the point where the energy we put in the transmitter is changed from an audio frequency to radio frequency. The gap may be a plain two-electrode gap, a quenched gap, or a rotary gap. The various forms of spark gaps are used to give a better tone or note to the transmitter. For example, the rotary gap may be supplied with sufficient electrodes to produce 500 sparks a second, thus giving a note which is more pleasing and easier to read than the lower frequencies of the plain gap. The spark gap will always have two fundamental connections even if there are a large number of electrodes.



SWITCHES—The most common switches used in radio are the following: single-pole, single-throw (SPST) with two connections, single-pole, double-throw (SPDT) with three connections, double-pole, single-throw (DPST) with four connections and double-pole, double-throw (DPDT) with six connections. These switches are made up in standard form and also in a special anti-capacity type with the area of the switch parts reduced to a minimum. Of course there are also three and four-pole switches but their use is less common. Whatever the number of connections, it is merely necessary to count them on the diagram and make sure that the switch itself has the same number of connections and the same number of switch arms. Such switches may be used for antenna switches, battery chargers, etc.



TELEPHONES—A good pair of telephones is essential for reception; probably the best way of selecting them is to buy from a reliable manufacturer. There are two common types; in one the magnets act directly on the iron diaphragm and in the other they act on an iron armature which is mechanically connected to a mica or composition diaphragm. Either of these types is satisfactory if well made. The two telephone receivers are always connected in series, that is, one terminal of one phone is connected to one terminal of the other phone and the remaining two terminals are brought out for connections to the receiving set. For any good receiver, the telephone headpieces act as the mouthpiece and if they are of good design and quality the results will be good. If the telephones are inferior, however, reliable results cannot be expected. A good receiver deserves a good headset.

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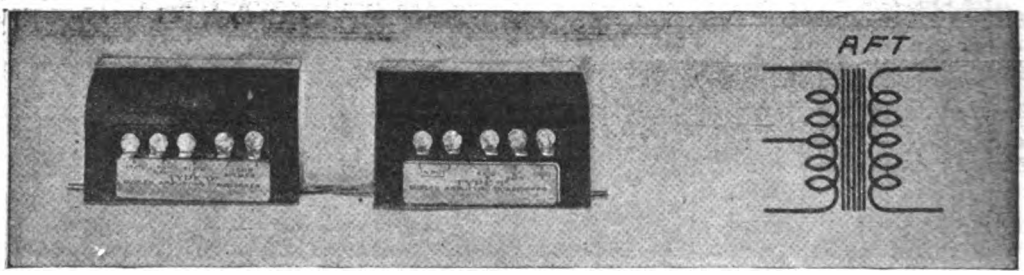
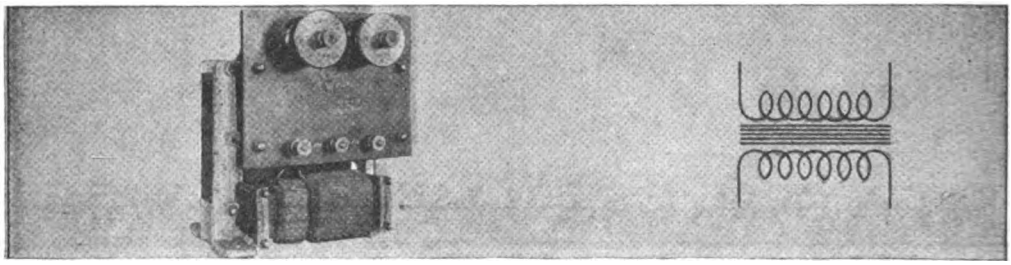


PUSH-PULL TRANSFORMER—For each stage of push-pull amplification we must have a special audio-frequency, input transformer with a tap at the center point of the secondary winding, and also a special audio-frequency output transformer with a tap at the center point of the primary winding. Therefore the push-pull transformers are usually sold in pairs. Push-pull amplification varies the plate current of both tubes up and down from the normal, thus giving an increase in signal strength. In a stationary condition, that is without any signal being inpressed on the tube, the direct current in one half of the output transformer opposes that in the other half and there is no flux in the core. With this condition we can use much higher voltages and get louder signals without distortion.



TRANSFORMERS—The transformer has two separate coils, both wound about the same closed iron core. The primary is the side connected to the source of power and has two terminals. The secondary is the side from which power is to be drawn at some voltage either higher or lower than that impressed on the primary. It has two terminals or may be tapped at several points to obtain a selection of voltages. Therefore, it can be seen that the transformer is fundamentally a device for changing the voltage of the supply. When the voltage is cut down by utilizing the drop across a resistance much energy is lost in heat; on the contrary the efficiency of the transformer runs as high as 98 percent in the larger sizes. The transformer cannot be used on direct current.

AUDIO-FREQUENCY TRANSFORMER—The audio-frequency transformer is merely a step-up transformer designed for voice-frequency currents. The primary is inserted in the plate circuit of one tube and the secondary in the grid circuit of the succeeding tube. Due to the step-up ratio, any change in the primary current and voltage produces a much larger swing in the grid voltage of the succeeding tube, and this causes a correspondingly greater change in the plate current of the same tube. The simple audio-frequency transformer has four terminals, two for the primary and two for the secondary. The general practice is to mark the primary terminals P and B for the plate and "B" battery connections and the secondary terminals G and F for the grid and filament connections. A transformer should have such characteristics that it will amplify tones of all frequencies, within the audible range of the ear, with equal intensity. Transformers that do otherwise produce distortion.

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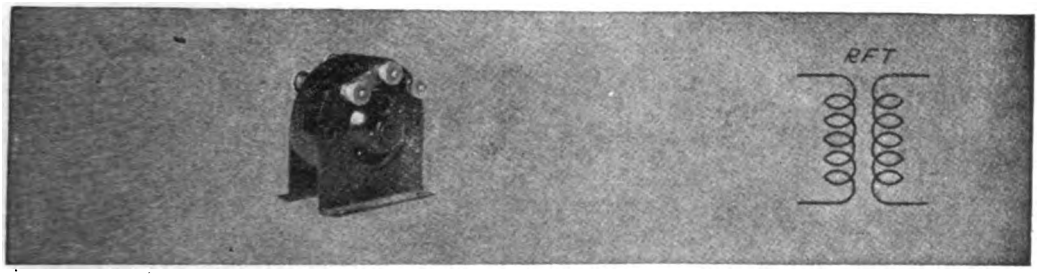
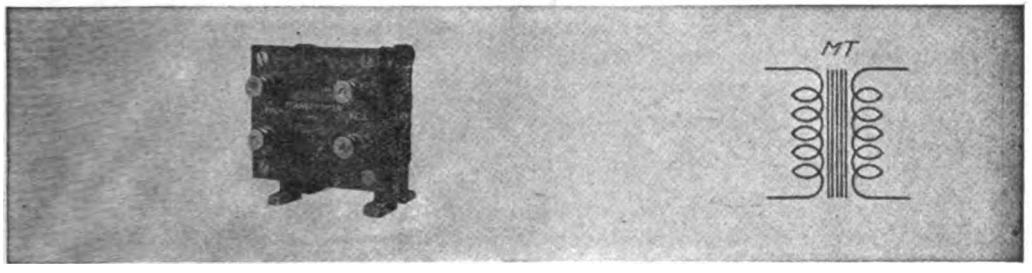
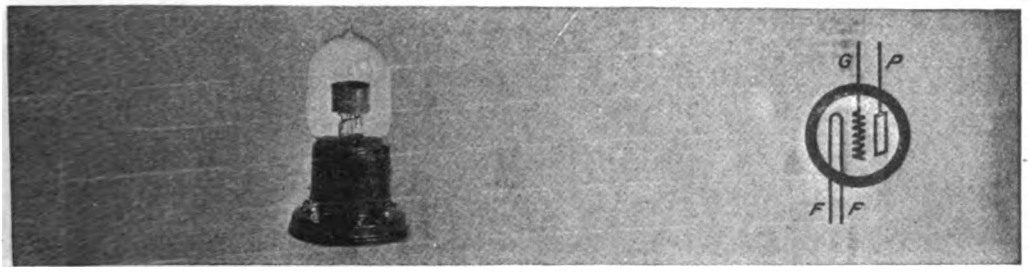


RADIO-FREQUENCY TRANSFORMER—The radio-frequency transformer operates on the same principle as the audio-frequency transformer, except that it is designed for high-frequency currents. It is often made with an air core, or at least with an open iron core. The radio-frequency transformer has four terminals, two for the primary and two for the secondary. The common practice is to mark the primary terminals P and B for the plate and "B"-battery connections, and the secondary terminals G and F for the grid and filament connections. Some transformers have a metal link for short-circuiting part of the winding, thus giving a wider wavelength range. Two or three steps of radio-frequency amplification are practically a necessity for loop operation. This type of transformer is not as efficient as the tuned type.



MODULATION TRANSFORMER—In order to couple together the microphone circuit and the grid circuit of a vacuum tube, a transformer must be used. Examples of this use are the grid-modulation, and Heising-modulation circuits. The modulation transformer is similar in appearance to the amplifying transformer, but usually has a higher step-up ratio. It has four terminals, two for the primary and two for the secondary. The primary winding of the modulation transformer is simply connected in series with the microphone and a suitable battery. The secondary winding is connected to the grid circuit of the oscillator tube in the case of grid modulation or to the grid circuit of the modulator tube in the case of Heising modulation. The transformers should be built to withstand rather high voltages.



VACUUM TUBE—The three-element vacuum tube has four terminals; two of these are the ends of the filament, the third is the grid, and the fourth is the plate. Since there are no designations for these terminals on the tube itself, it is imperative to purchase a suitable vacuum-tube socket and follow out the circuit from the letters on the same. The two filament terminals will be marked F, the grid G, and the plate P. These same letters have been placed on the diagrammatic vacuum-tube symbol shown, but will ordinarily be left off, as it is a simple matter to learn which element is which. The action of the vacuum tube cannot be treated here except to state that under normal operating conditions the telephone current flows from the plate to the filament, and that small changes in grid voltage will make comparatively large changes in the plate or telephone current. This process amplifies the currents passing through the telephones and produces louder signals.

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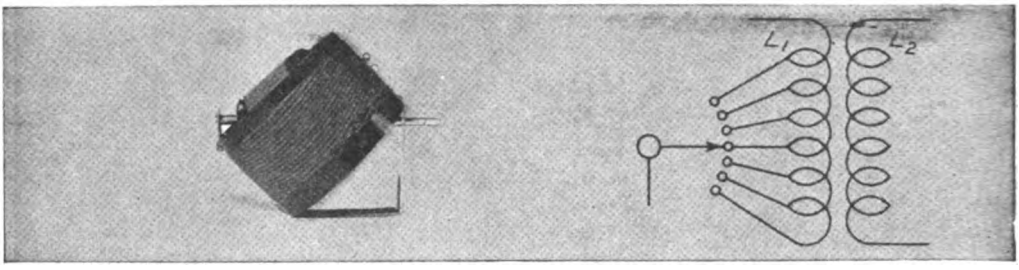
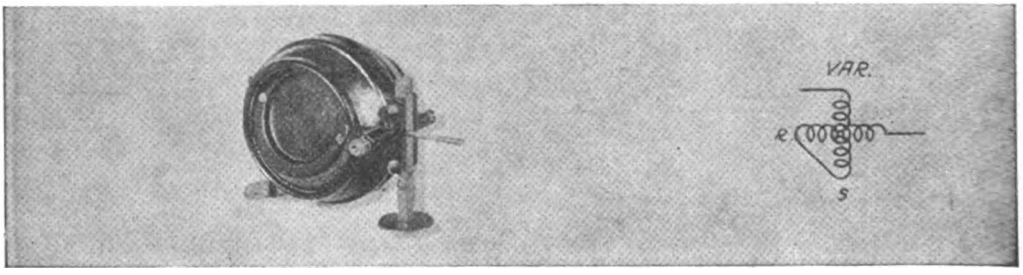
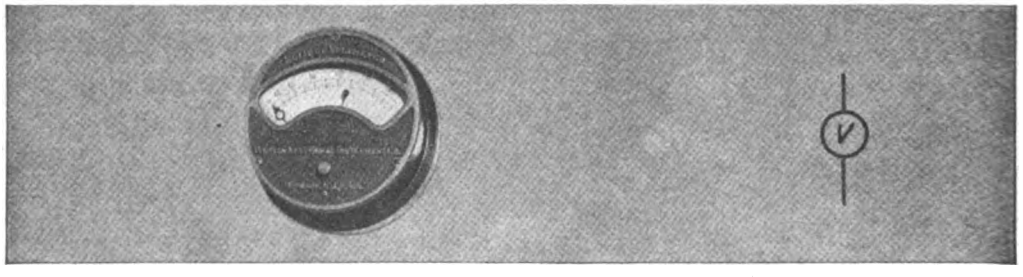


VARIOCOUPLER—The variocoupler is one of the most widely used instruments for coupling and tuning the primary and secondary circuits; it consists of a stationary primary coil, and a secondary coil rotating within the primary coil, so that the coupling between them may be varied. The primary of the variocoupler is provided with taps for changing the wavelength; there are two primary terminals, one to the wavelength switch and one to the end of the coil. The secondary of the variocoupler has a fixed number of turns and is always tuned by means of a variable condenser connected across the coil or by a variometer in series with it; there are two secondary terminals, one to each end of the coil. These secondary terminals are brought out through the bearings or through "pigtail" connections.



VARIOMETER—The variometer provides a continuously variable inductance (within the range of the instrument); it consists of two coils connected in series and mounted so that one rotates within the other. When the current traverses the two coils in the same direction and when the axis of the two coils are parallel, the inductance of the variometer is maximum; when the current traverses the two coils in opposite directions and when the axis of the two coils are again parallel, the inductance of the variometer is minimum and should theoretically approach zero. There are two connections to the variometer, one to the end of each coil; the opposite ends of the two coils are connected together.



VOLTMETER—The voltmeter is an instrument for measuring the potential difference (voltage) between two points in a circuit, that is, how much higher the voltage is at one point than at the other. For instance, it might be connected across the "A" battery to measure the difference in voltage between the positive and negative terminals. A voltage measurement is the only satisfactory method of testing "B" batteries or of locating a bad unit among them. After the voltage of the 22½-volt unit has fallen below 16 it should be discarded. The same proportional drop can be applied to the larger units. The simple voltmeter will have two terminals for connecting to the two points where the voltage difference is to be measured. For "B" battery measurements the voltmeter should be of high resistance.

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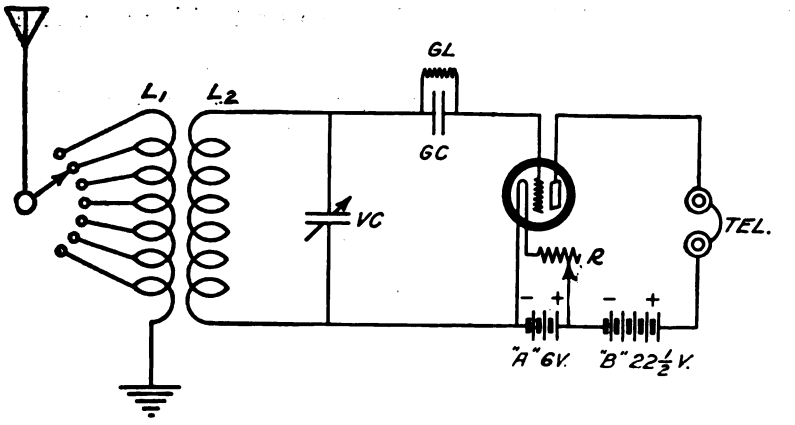

FIGURE 1: A DRAWING FOR A STRAIGHT AUDION CIRCUIT
Unless you know what these symbols mean, this diagram is unintelligible. This article tells you how to read it.

How to Apply this Information to an Understanding of the Standard Diagram Above

From a reading of the foregoing the reader will notice that such instruments as the variable condenser, the variometer, the fixed condenser, the grid leak, the rheostat, tuning coil, choke coil, battery and others have only *two* terminals.

The potentiometer has *three* terminals.

Most types of transformers have four terminals—two for the primary winding and two for the secondary winding. Push and pull transformers, it will be noticed, have five connections.

Tube sockets have four connections, one marked G for the grid, one marked P for the plate, and the other two marked F for the filament connections.

Variocouplers have a number of taps (inductance terminals) for the primary and two connections for the secondary.

Some of the other more complicated accessories have a large number of terminals; among these are motor generators, tapped coils and power transformers.

Consider the specific case of a variable condenser; if you see the symbol for this instrument in a circuit diagram you will always find two lines (wires) running to it, one from each side. If you were to connect this instrument in that particular circuit you would only have to connect these two wires to the two terminals that you would find on the condenser. This same line of reasoning holds true for instruments with three terminals, four, or more terminals.

In a variocoupler the primary coil is always the larger outside coil and the secondary is the smaller inside coil.

In a transformer (radio-frequency or audio-frequency) the primary terminals are marked P for the plate, and B for the wire going to the "B" batteries. The secondary terminals are marked G, for the grid wire and F for the wire leading to the filament.

The symbol for the vacuum tube, it will be noticed, contains four lead wires. The upper left-hand wire is the grid lead and when connecting up a vacuum-tube circuit this wire should always be connected to the terminal marked G on the tube socket. The upper right-hand wire is the plate lead and this should always be connected to the terminal marked P of the tube socket. The other two wire leads (in the diagram) are the filament

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connections and should be connected respectively to the terminals marked F on the tube socket.

Now let us study the diagram in Figure 1.

This is a standard diagram for a straight audion circuit. We will first pick out the instruments that are used in this circuit. By referring to the upper left-hand portion of the diagram we will find the triangular-shaped symbol for the antenna. Directly below it we find the symbol for a variocoupler. And below this we find the symbol for the ground. Then connected to the secondary of the variocoupler we find the symbol for a variable condenser. And in the center of the diagram we find the symbol for a vacuum tube. Directly below this we find the symbol for a rheostat and an "A" battery. Connected between the grid of the tube and the variable condenser we find the symbols for a fixed condenser and a grid leak. To the right of the diagram at the top we find the symbol for the telephones and below this the symbol for a "B" battery. From this diagram, therefore, we learn that we need the following list of parts in order to make the set:

1—variocoupler;
1—variable condenser;
1—grid condenser;
1—grid leak;
1—vacuum tube;
1—vacuum-tube socket;
1—rheostat;
1—"A" battery (for lighting the filament);
1—pair of telephones;
1—"B" battery (for supplying the plate current).

The next thing to do would be to obtain these parts of suitable sizes to incorporate in the set. The sizes for the various instruments are almost always given in the text of the article of which the diagram is a part. These sizes include the proper capacities for the variable condensers and fixed condensers, the proper resistances for the grid leaks and rheostats, the proper type of tube to use for detector or amplifier and the proper voltages to use for the "A" batteries and "B" batteries.

To start wiring up a set like the one shown in the diagram the beginner should obtain the proper connecting wire, a soldering iron, some solder, soldering flux and a heavy red pencil.

A good layout for this particular set would be to mount the variocoupler at the left-hand end of the panel; place the variable condenser beside it, with the socket mounted alongside the variable condenser, at the right-hand end of the panel. The rheostat should be mounted on the panel directly in front of the vacuum-tube socket. The vacuum-tube socket should be mounted on the base with the plate and grid terminals turned toward the back of the set.

Now we should include on the left-hand end of the panel, two binding posts, one for the antenna and one for the ground. At the right-hand end of the panel should be mounted six binding posts, the top two being for the telephone, the second pair for the "B" battery, and the bottom two for the "A" battery.

After the instruments have been mounted on a panel in a manner which will keep the connecting wires as short as possible, we should commence the actual wiring.

From the diagram we see that there is a wire running from the antenna to the switch arm of the variocoupler. Cut a piece of wire long enough for this purpose and solder one end of it to the back of the antenna binding post of the set. Then run the wire as direct and neatly as possible to the shaft of the switch arm on the panel.

When this is completed *take the red pencil* and cover the line you have just completed (on the diagram) with a red line.

In looking at the diagram hereafter you will know that you have already completed this connection; it will be evident at a glance.

Now you will notice from the diagram that there is a wire running from the ground to the bottom end of the vario-

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coupler. Connect this to the back of the ground binding post and also to the variocoupler end. Then trace over this line on the diagram *with the red pencil.*

There are five taps to be connected to the switch points on the panel, from the primary winding of the variocoupler. Make these connections one by one and each time you complete one trace it over on the diagram *with the red pencil.* The primary circuit is then complete.

The top end of the secondary is then run direct to one terminal of the variable condenser. Make this connection and *use the red pencil.* It will be noticed that there is a joint from this wire leading over from the wire you have just connected which runs to one side of the grid leak and one side of the grid condenser. Make this connection and trace over *with the red pencil.* Now connect a wire from the terminal marked G on the tube socket and run it to the opposite sides of the grid condenser and grid leak to the connection you have just completed. Cover this *with a red pencil line.*

To get back to the variocoupler, we notice that there is a wire running from its bottom end over to the negative "A" battery. Make this connection on your set and again cover on the diagram *with the red pencil.*

There are two branches from this wire, one to the remaining terminal of the variable condenser, and one to one of the terminals marked F on the tube socket. Make these connections separately, after which *use the red pencil.*

Now there is a connection running from the positive "A" battery over to the negative "B" battery and this requires a wire connecting your A binding post and your B negative on your set. This wire also has a branch running to the pointer on the rheostat. Connect these and *mark off* on the diagram.

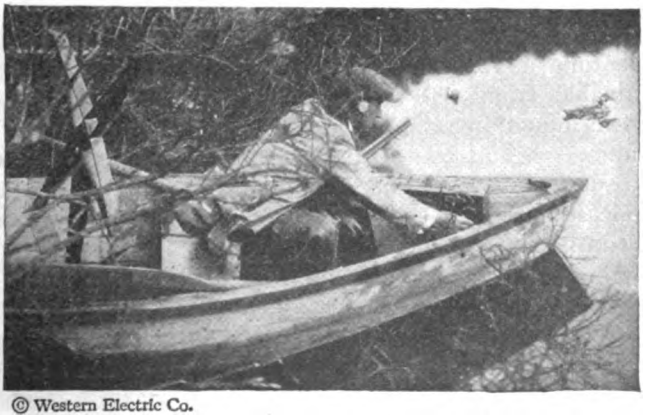
The other terminal of the rheostat is connected to the remaining terminal marked F on the tube socket. Do this and *mark off* on the diagram *with the pencil.* There are now two connections left to complete the wiring. One is a wire from the "B" battery positive to the telephones and this requires the connection of the binding post marked B and the nearest telephone binding post. The other wire should be connected between the remaining telephone binding post and the terminal marked P on the tube socket. *Mark off* the two last connections *with the red pencil.*

Now look at the diagram again. Are there any connections left *uncovered by the red pencil?* If not, the set is correctly connected and you have succeeded in reading an electric diagram!

Try this out and you will find that even the most complicated circuits are subservient to your wishes and you will never have any trouble nor make any mistakes. There is nothing to it!

Radio on a Wild Duck Chase

Here is a novel idea—originated by Alfred Reilly of Boonton, New Jersey, who is both an ardent radio fan and a duck hunter—for enjoying both of his favorite recreations at one and the same time. He has equipped his boat with a receiving set, and while he awaits the arrival of his prey, he whiles away his time listening-in on the ether waves.



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From a photograph made for POPULAR RADIO

LABORATORY EXPERIMENTS WITH DIFFERENT KINDS OF AMPLIFIERS

At Columbia University Mr. L. Aceves, the noted research electrical engineer, has developed some remarkable audio-frequency amplifiers in which the amplification of voice-currents and music is accomplished with almost unbelievable volume—and without distortion.

Amplification *without* Distortion

What makes an amplifier produce clear signals? What makes it distort? Why are some amplifiers pleasing to listen to while others are unpleasing? Just what kind of an audio-frequency amplifier should be used with a loud-speaker? What kind should be used for broadcasting? What kind of amplifier gives the loudest signals? What kind gives the clearest reproduction? Read this article and find out.

By DORMAN D. ISRAEL

THE ideal audio-frequency amplifier should operate without distortion, have a uniform amplification factor for all frequencies and intensities within the predetermined range, and at the same time deliver the maximum power obtainable from the tube used at the predetermined maximum intensity of input.

In designing a speech amplifier for broadcasting equipment, it is necessary to consider frequencies from 25 to 20,000 cycles. The lower limit is determined by the fact that certain musical instruments such as the organ or double bass operate as low as 25 cycles. The upper limit is, of course, above the range of the normal ear so far as the fundamental is concerned, but when it is remembered that harmonics are present which play a vital part in the peculiar characteristics and qualities of instruments, the reason for setting the limit at 20,000 cycles is obvious.

To elaborate, if the only musical instrument used were a tuning fork with its perfect sine wave note, a tremendous amount of complications would be avoided. However, there is practically no instrument used which has a sound

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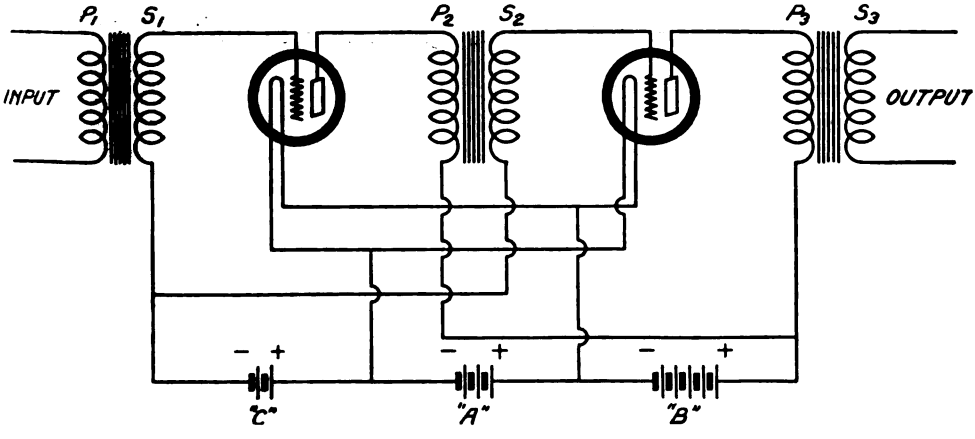
wave in any way approximating a sine curve, which proves that for recognizable reproduction, the harmonics may not be ignored. If a violin is playing a 2,000 cycle note, its eighth harmonic will be 16,000 cycles. Without the reproduction of these harmonics, the violin would sound like a tuning fork, for only the fundamental would be present.

The amplification curve of the amplifier, plotted against frequency with constant input e.m.f., must be flat, within the range of frequencies predetermined. If this is not the case, certain notes will be heard louder than the rest, or certain harmonics will be disproportionately loud, and the effect will be distorted reproduction.

In order that these requirements may be fulfilled, it is often necessary to sacrifice efficiency in intensity and amplification to obtain quality. Usually it is possible to amplify *perfectly,* with two stages, to the same intensity as could be done *imperfectly,* in one stage.

The most commonly used audio-frequency amplifier is the transformer-coupled type. It will be seen from the diagram in Figure 1 that the first tube is coupled to the input circuit through a transformer, the primary of which, P1, is suited to the impedance of that circuit. In receiving equipment, the detector tube characteristics determine this impedance and in broadcasting equipment, it is the microphone. Any variation in primary current will produce a corresponding alternating electro-motive-force (e.m.f.) across the secondary coil, S1, which e.m.f. is impressed on the grid circuit of the first tube. A corresponding change in plate current of this tube occurs, along the characteristic of the tube, which current flowing through winding, P2, of the second transformer produces an alternating e.m.f. or voltage across winding, S2. The plate current flowing through winding, P3, produces an alternating e.m.f at secondary winding, S3, in the same manner as outlined above for the previous stage. The winding, P3, is determined by the second tube's plate impedance and S3 depends on the output-circuit impedance. The output circuit, in the case of a receiving outfit, is a loudspeaker or headset. Quite often, the third transformer is omitted and the headset or loudspeaker is placed directly in the plate circuit of the last tube. For a transmitter, the output circuit may be a larger amplifier tube or a modulation system.



THE TRANSFORMER-COUPLED AUDIO-FREQUENCY AMPLIFIER

FIGURE 1: *This is a standard amplifying circuit with the exception that there is included, in the grid circuits, a grid-biasing battery called a "C" battery. This will often help to reduce distortion in a circuit of this kind.*

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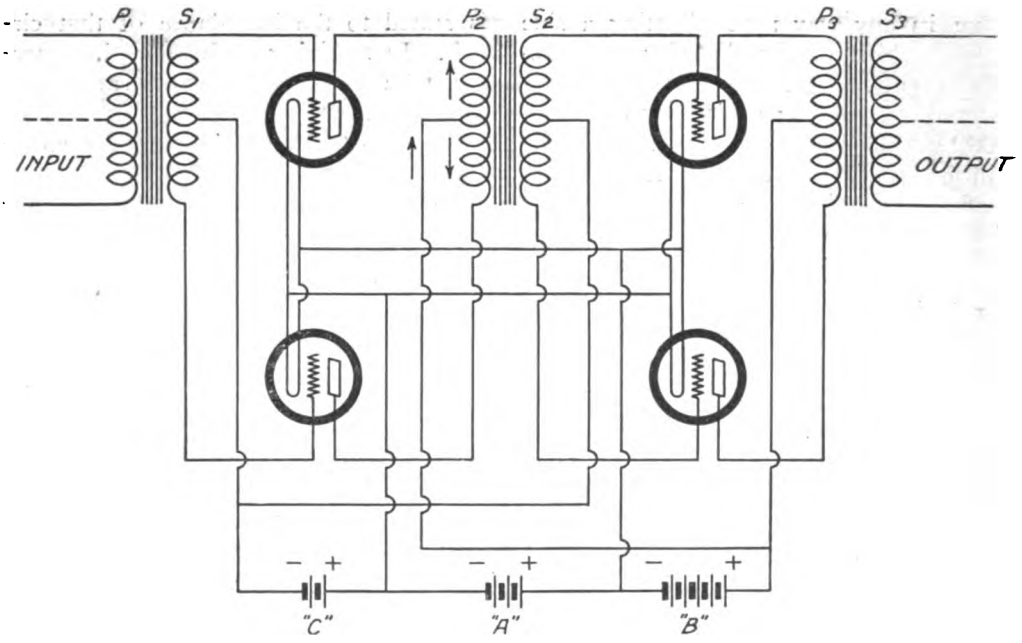

THE PUSH-AND-PULL AUDIO-FREQUENCY AMPLIFICATION CIRCUIT

FIGURE 2: *By means of split-winding transformers and the use of two tubes per stage, the distortion due to the permanent magnetization of the iron cores is eliminated. This type of amplification gives exceptionally good reproduction.*

The transformer-coupled amplifier is the *most efficient* type of audio-frequency amplifier but, in most cases, the *poorest* from the point of view of quality of reproduction. It takes advantage of the amplification constant of the tube and, in addition, by means of a step-up ratio of the transformers, the secondary voltages are raised so that with the present receiving tubes having a voltage-amplification constant of about 6, it is possible to obtain amplification as high as 20 or higher. However, distortion is introduced mainly because iron-core transformers must be used. There is a steady value of plate current flowing through the primaries, and when variation takes place, the operation is not within the straight line portion of the B-H curve of the laminations. In addition, a minute hysteresis loop is traced, introducing distorting harmonics. The frequency range of the transformers is also usually limited, the best of transformers showing good behavior only over a range of up to 2,000 or 3,000 cycles.

As was already mentioned, the chief difficulty with the transformer-coupled amplifier lies in the fact that the cores of the transformers are *saturated* by the plate current of the tube, flowing through the primary winding. By use of a larger core this may be partially overcome but, at the same time, the core losses will be increased, causing a lessening in the efficiency of the transformer so far as intensity is concerned.

It is possible to avoid this difficulty and yet to get the same or a greater amount of amplification by making use of a back-to-back or push-pull connection thus eliminating the constant value of flux in the cores.

The connection for two stages is shown in Figure 2. The operation of the input transformer is the same as in the first-mentioned type except that there is a mid-tap on the

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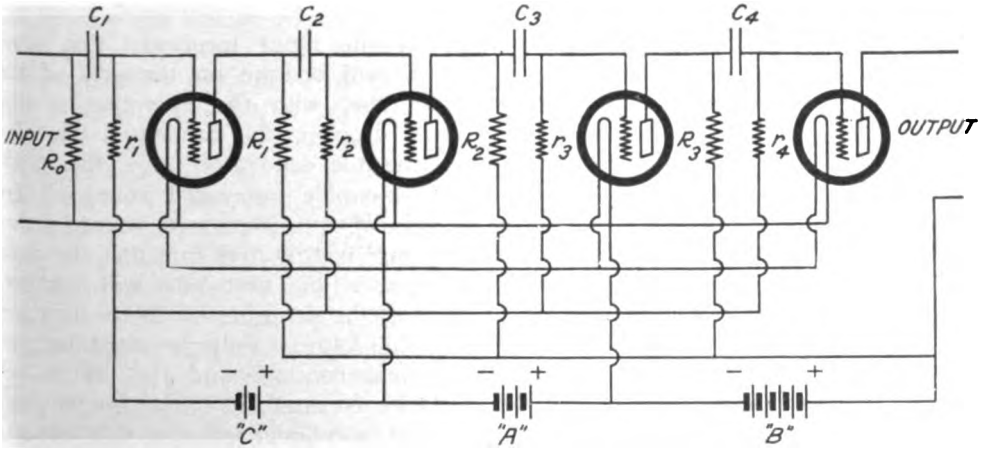
secondary connected through a negative-grid-bias battery to the filaments. At a given instant, the outer terminals of S1 will be positive and negative respectively so that the grids of the tubes in the first step are 180 degrees out of phase. The corresponding plate currents will be increasing and decreasing, respectively. Before any disturbance was made, the plate battery currents will be as indicated by the arrows and since the tubes are identical and have the same grid potential, the plate currents will be equal and flow in opposite directions in the transformer winding, P2. At equilibrium, therefore, *there will be no flux in the core of the transformer,* but when an alternating e.m.f. is impressed on the grids of the tubes, as described above, there will be a resultant flux in the core which will induce an alternating e.m.f in winding, S2. The action is the same in the second step through the output transformer as described in the first case. The dotted mid-tap shown on the input transformer is necessary if a double button microphone had been used or if the previous steps had been from a similar amplifier. If the back-to-back principle is followed through further amplification, the output transformer must also be tapped as indicated by the dotted line.

It would appear that the amplifier just described would be only fifty per-cent as efficient as the standard transformer-coupled type, but when it is remembered that for the same total output, tubes of only one-half the output rating may be used in the push-pull amplifier, it is understood that the two *are equally efficient.* In addition, the push-pull amplification transformers *have no steady flux in their cores so that the quality of reproduction as well as the range of frequencies is bettered.* There remains, however, the distortion due to operation over the hysteresis loop which is always present in an iron-core device.

Transformer-coupled amplifiers of either type are decidedly limited as to frequency and are not, unless carefully designed, faithful in their reproduction due to the introduction of harmonics from iron cores. The resistance and condenser-coupled amplifier shown in Figure 3 is decidedly better from these points of view. It is, at once, obvious, however.



THE RESISTANCE AND CONDENSER-COUPLED AMPLIFIER

FIGURE 3: *If properly designed this type of amplifier will give better reproduction than either of the other two types of transformer-coupled amplifiers. This scheme is almost universally used in broadcasting for amplifying voice-currents before impressing them upon the transmitter.*

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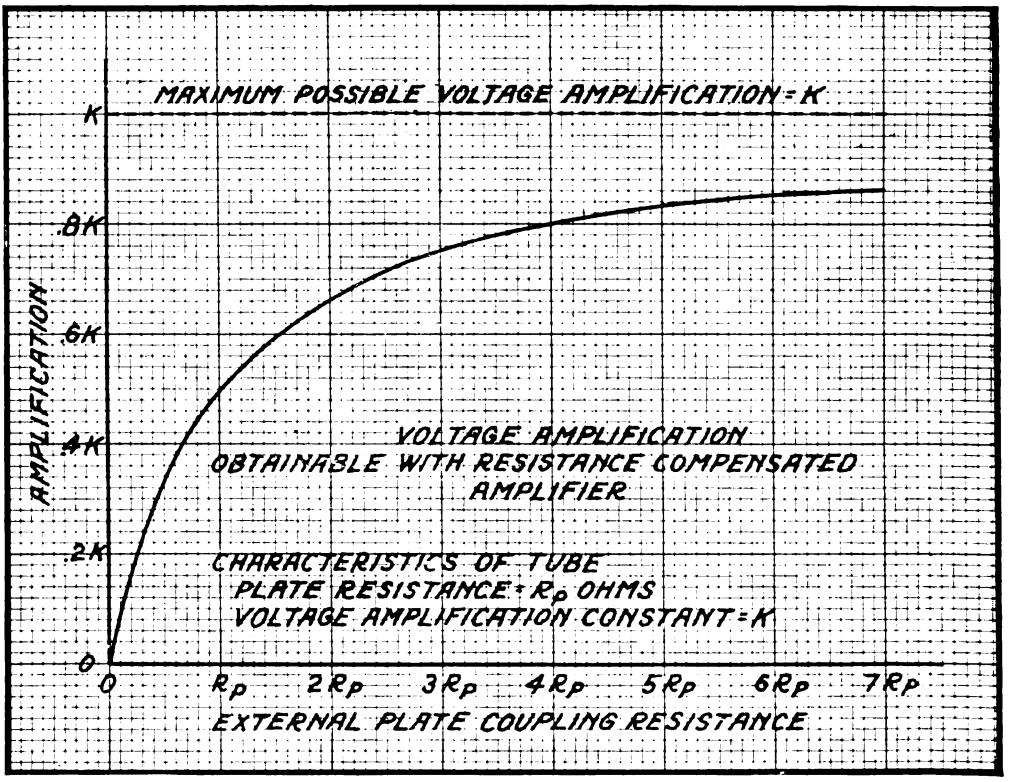

THE MAXIMUM AMPLIFICATION THAT CAN BE OBTAINED WITH THE RESISTANCE-COUPLED AMPLIFIER

FIGURE 4: *It will be noticed that, as the value of the plate resistance is increased, the amplification obtainable is also increased up to a certain point, where it remains constant.*

that it is impossible to get an amount of amplification from each tube greater than that determined by its own amplification factor. Even this condition is *never reached,* as will be explained later. The input may be through a transformer as before or it may be through a coupling resistance and condenser from a smaller tube as shown. The condensers C1, C2 and C3 are identical for the same type and size of tubes as well as the grid resistances, r1, r2 and r3 and the plate resistances R1, R2 and R3.

In addition to the grid leaks, it is often advisable to use a grid battery to establish the proper operating grid potential. The battery is shown at C. When an alternating e.m.f. is impressed across the input terminals, that same e.m.f. will operate on the grid of the first tube, with the exception of the small drop in the condenser C1. By making the condenser large, the maximum possible impressed voltage is assured. If this impressed voltage is increasing in a positive direction, the plate current of the first tube will increase, causing the drop across R1 to increase. As the battery voltage supplying the plates is constant and the battery resistance is small in comparison to that of the remainder of the plate circuit, the plate voltage of the first tube will be decreased correspondingly. This decreasing voltage is impressed across the grid and filament of the second tube where the same process is repeated and

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so on throughout the other stages of the amplifier.

Assuming the drop in the coupling condensers to be negligible (this will be treated in detail later), it is possible to express the amplification per tube as follows.

Let,

I_p = effective value of the a.c. component of the plate current of tube number 1.

k = voltage amplification constant of the tube.

E_{g1} = effective value of a.c. voltage impressed upon the grid of tube No. 1.

R_p = a.c. plate-to-filament resistance of the tube.

R_1 = external plate coupling-resistance, as shown.

then $I_p = \frac{k E_{g1}}{R_p R_1}$

E_{g2} the effective value of a.c. voltage impressed upon the grid of the second tube, will be

$$I_p R_1 = \frac{R_1 k E_{g1}}{R_p R_1} = E_{g2}$$

and the ratio $\frac{E_{g2}}{E_{g1}} = \frac{k R_1}{R_p R_1}$

which is the voltage amplification obtained per stage of tube.

It is thus seen that as R_1 is made large, the maximum amplification obtainable is of the value, K. The accompanying curve shows this action graphically. It must be remembered, however, that as R_1 is increased, it is necessary to increase the voltage of the plate battery accordingly, or the normal voltage on the plate of the tube is so decreased that its amplification constant is decreased.

The drop across the grid-coupling condensers, as has been mentioned before, must be small in comparison to the total value, $I R_1$. In other words, the reactance of the grid condenser must be small in comparison to the resistance of the parallel circuit, composed of the grid-leak resistance and the internal grid-to-filament resistance of the tube. Here again, the wide range of frequencies, to be accounted for, establishes a weakness. As 25 cycles was taken as the minimum frequency, the condensers must have a comparatively large capacity. But when the condensers are made large, another consideration enters. If the grids of the tubes were operated free, that is, with no grid leaks, which corresponds to an infinite leak resistance, the action would be erratic.

In the above condition, a sudden stray negative voltage on the grid of a tube might cause the plate current of that tube to drop to zero. Due to the insulation of the grid through the condenser, the plate voltage would not appear until the charge was removed from the grid. This action is commonly termed "blocking" of the tube, and it is for this reason that the leaks are used. Now if a condenser, C, and a leak, R, are used on a tube, the time for the grid to resume its operating potential is defined by the time constant, RC seconds. If, therefore, the capacity of the condensers is increased, the amplifier will tend to distort so that to bring the time constant back to the proper value defined by the frequency of the highest note, the resistance of the grid leaks must be decreased. In so doing, the drop $I_c r_g$ which is the actual voltage affecting the grid will be reduced. It is therefore seen that the proportioning of leak resistance and condenser capacity is a compromise. A further effect in this amplifier enters when the leak voltage drop is made to compare with the condenser drop. In this case, the amplifier will operate with greater intensity on notes of higher frequencies because the ratio of leak voltage to the voltage drop across the condenser changes appreciably.

From the above discussion, it is obvious that the plate coupling-resistances may be displaced by high-inductance chokes of comparatively low resistance. In this way, greater amplification may be obtained from a plate battery of the same voltage. However, the element of iron losses and distortion due to the iron core enters to counterbalance the increased amplification.

Due to the more faithful reproduc-

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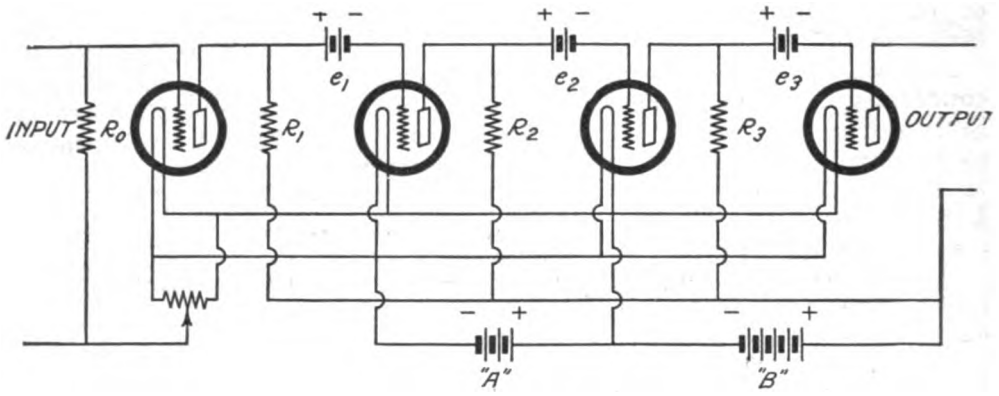

THE APERIODIC RESISTANCE-COUPLED AUDIO-FREQUENCY AMPLIFIER

FIGURE 5: *This is at the same time the purest reproducer and simplest of the resistance type of amplifiers. Although its over-all amplification is by no means as great as in the case of the transformer-coupled type, nevertheless it has its peculiar advantage, because all possibility of distortion is eliminated.*

tion obtained, the resistance and condenser-coupled amplifier described above has been adopted to considerable extent for the speech input amplifiers on broadcast transmitters. The practice has been to use more tubes and get good quality rather than to use transformer-coupling with its high amplification and possible introduction of distortion. The resistance and condenser-coupled amplifier, however, is limited to the upper frequencies, but since most musical and speech reproduction is above 200 cycles, satisfactory operation is obtained.

There is an amplifier that is simpler than the ones described above which responds uniformly to all frequencies from zero, or d.c., to about 100,000 cycles, at which frequency the internal capacity-coupling in the tube limits the operation. In other words, it is an *aperiodic* amplifier. Its circuit is shown in figure 5 for four stages. The plate coupling-resistances, R_1, R_2, R_3, are designed in the same manner as in the case of the resistance and condenser-coupled amplifier. The grids are coupled *conductively* to the plate of the preceding tube through a small battery. It is the purpose of these batteries to neutralize the plate voltage and thereby to establish the proper potential on the grid. Since there are no condensers or inductances in the circuit, all possibility of distortion is minimized. Further, it will be seen that there is a through conductive path, making d.c. amplification possible. It is a simple matter to positively adjust this amplifier.

The apparatus required for a four-stage unit is as follows:

4 Western Electric 216-A vacuum tubes or equivalent;
4 sockets for above tubes;
6 Western Electric 38-A, 48,000-ohm resistance units (or equivalent) 96,000 ohms per plate;
1 "A" battery potentiometer, 200 to 400 ohms;
1 D.C. milliameter, 0-25 milliamperes;
1 input discharge resistance, 50,000 to 100,000 ohms;
1 storage "A" battery, 6 volts;
1 "B" battery, 120 volts, capable of delivering 50 milliamperes;
3 "C" batteries, 45 volts each, adjustable, current practically nil.

Operating Data

Be sure that all connections are as illustrated in Figure 5 in the section explaining the theory of the amplifier. Obtain the static characteristic curves for the tubes used, so that the value of

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plate current for proper operation may be determined. For the 216-A tubes, this is about 9 to 15 milliamperes, and is obtained for the last tube when the grid is connected directly to the negative filament lead. When these tubes are used, disconnect the grid of the last tube from the negative of e_2, and connect it temporarily to the negative filament terminal. Note the plate current as read for the last tube on the milliameter, say 11 milliamperes. Now disconnect the grid of the third tube (from the left on diagram) from the battery, and connect it to the negative filament, at the same time connect the grid of the fourth tube to its battery. Adjust the connection of e_3 until the original normal plate current is restored to the last tube, 11 milliamperes in this example. Connect the grid of the second tube to negative filament, and adjust e_3 to give normal plate current in the last tube. Finally connect the grid of the first tube to negative filament and adjust l_2 for normal plate current in the fourth tube. The complete amplifier, excepting the first stage, is now correctly adjusted to give maximum amplification with minimum distortion. The critical adjustment on the first tube is made when the input transformer has been connected. Under this condition, the potentiometer is regulated until the plate current of the last tube is once again restored to normal value.

The amplifier is simple and easy to operate, once the initial adjustments have been made. One point must be continually observed; *the plate current of the last tube should not be allowed to change or "dance."*

Any movement of the needle on the meter indicates the presence of distortion. It is best to provide a means for controlling the input to the amplifier, and, by means of this control, the current must be kept steady and fixed.

G. H. Dacy

A PORTABLE SIX-TUBE RECEIVER COMPLETE IN A SUITCASE

It includes three stages of radio-frequency amplification, detector and two stages of audio-frequency amplification, a loop antenna and batteries and is entirely contained in the suitcase. The tuning dials are located on the exterior (near the carrying grip) and the suitcase can be carried while the set is in operation.

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In justice to our regular subscribers, the Service Bureau is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service and this sum must be enclosed with the letter of inquiry. No inquiries can be answered personally or by telephone.

THE flood of inquiries that has poured in upon the Service Bureau has not only furnished evidence of the need of this department, it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to co-operate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

So many of our readers have written in for more detailed information concerning some of the parts which have been mentioned in some of our recent articles—particularly in our September and November issues—that the additional data is given below. Ordinarily the Technical Editor does not recommend that any but the most experienced of our readers should attempt to make certain apparatus, partly because the average fan has neither the facilities nor the experience, and partly because the results of his efforts would in many (if not most cases) be unsatisfactory—and the circuit described or POPULAR RADIO itself would be blamed for the failure. For the benefit of the more experienced few, however, the following specifications are submitted:

The coupler specified for the Haynes and the super-heterodyne circuits:

A coupler which will be suitable for use in the Haynes circuit (described in POPULAR RADIO for September, 1923) may be made by winding, on a 3½-inch composition tube, 65 turns of No. 22 DSC wire (for the secondary) and continuing this winding for ten turns more (for the primary). The primary is tapped at the second, fourth, sixth and tenth turns. Both the secondary and primary are on the stator tube. The rotor tube is a 3-inch tube with 35 turns of the same kind of wire, and is made for rotation over 180 degrees.

The oscillator coupler specified for the super-heterodyne circuit:

An oscillator coupler may be made on two similar sized tubes as the coupler for the Haynes circuit. The larger tube (stator) contains two windings spaced ¼ inch apart. These windings K2 and K3 contain ten turns each of No. 22 DSC wire. The rotor winding K4 has 15 turns of the same size wire.

The radio-frequency transformers specified for the super-heterodyne circuits:

These transformers are wound in two slots cut out of a piece of hardwood. The core for the windings should be ⅝ inch in diameter. The slots for the primary and the secondary windings should be ¼ inch wide and the two slots separated by a distance of ⅛ inch. For the input transformer wind, on the primary, 300 turns of No. 36 DSC wire. For the secondary wind 1,000 turns of the same size of wire. For the other three transformers, wind, on the primary, 850 turns of No. 36 DSC wire and for the secondary wind on 1,000 turns.

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QUESTION: Would it be possible to use my four WD-11 tubes on a storage battery if I put all the tubes in series on the full six volts? I have a set that includes one stage of radio-frequency amplification, detector, and two stages of audio-frequency amplification: four tubes in all. I had the thought that I might put all the tubes in series on the six-volt storage battery that I have. At present I am using dry cells and the batteries run down so fast that I am getting tired of replacing them. That is what made me think of the storage battery. Each tube takes 1½ volts and the four would (it seems to me) operate on the six volts all right.

ERNEST H. ELLIS

ANSWER: You will be able to use the six-volt battery in the way you have described, with the four tubes connected in series. You will require, however, a potentiometer connected across the "A" battery with the mid-point of the potentiometer connected to the grid return of the first tube. The other three tubes should have their grid returns connected to the negative side of the filaments of each successive tube for proper action. Use only one rheostat for the four tubes. You may have to experiment with the set for a while before you get it going to the fullest efficiency but the thing can be done and should give very satisfactory results.

QUESTION: Can a counterpoise ground system be used for receiving as well as transmitting or is this form of ground suitable only for transmission?

J. B. BARTINDALE

ANSWER: The counterpoise can be used for both purposes. It will sharpen up the tuning in a receiving set, by reducing the radiation resistance of the whole antenna system.

* * *

QUESTION: Are battery chargers really successful and reliable?

CHARLES JOHNSON

ANSWER: Battery chargers of reliable manufacture are not only successful but they have become an almost indispensable part of the equipment of a modern receiving or transmitting station.

* * *

QUESTION: Will you please give me what you believe to be the most practical hook-up for a crystal detector. I want the simplest circuit that will be consistent with the greatest distance of reception, and sharpness of tuning.

LAWRENCE DURHAM

ANSWER: The circuit diagram is shown in Figure 1. C1, C2, and C3, are mica fixed condensers of .0001 mfd., .00025 mfd., and .0005 mfd. capacity, respectively. They are used to obtain a low, medium, or high wavelength range. The variometer VAR, is used for selective tuning.

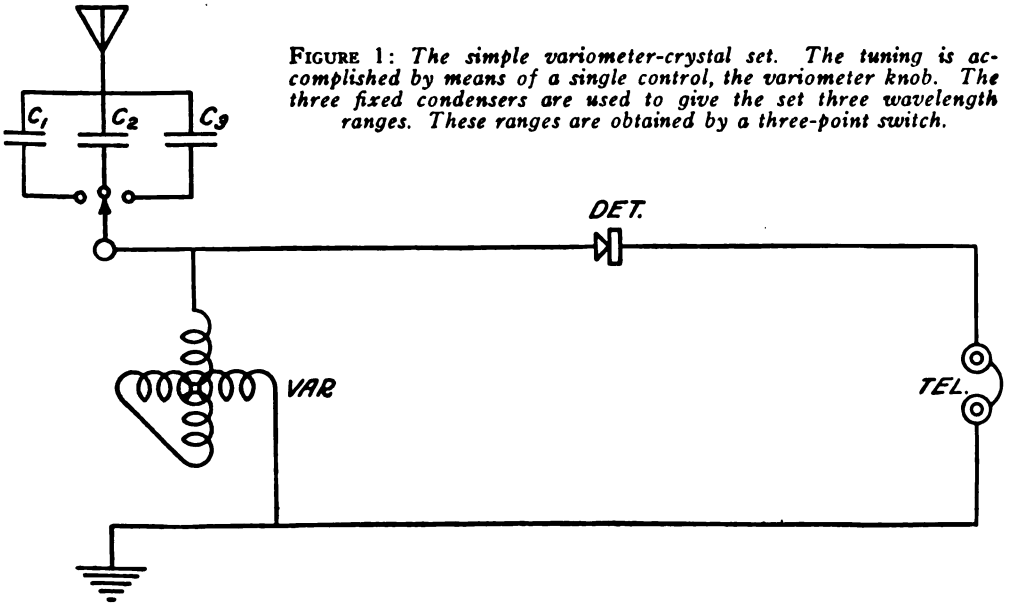

FIGURE 1: *The simple variometer-crystal set. The tuning is accomplished by means of a single control, the variometer knob. The three fixed condensers are used to give the set three wavelength ranges. These ranges are obtained by a three-point switch.*

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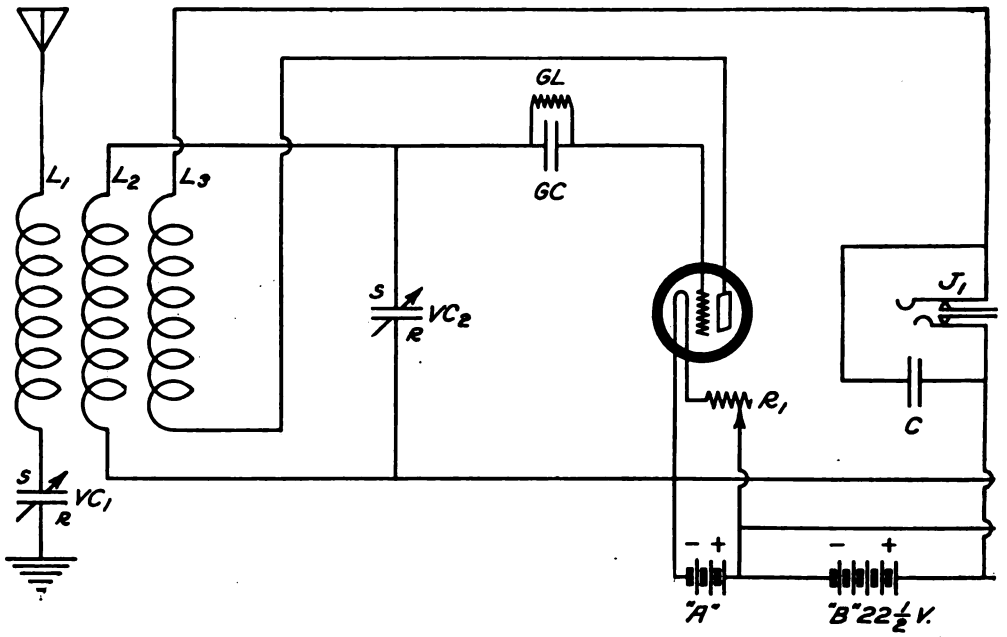

QUESTION: I would like to get the proper information and the hook-up for adding two stages of audio-frequency amplification to my present triple-coil set. I have only one tube, and wish to use two more to work a loudspeaker.

Will you also furnish me with a list of parts?

HAROLD FREEMAN

ANSWER: The proper diagram for your completed set will be as found in Figure 2. The extra parts that you will need are:

AFT1 and AFT2—audio-frequency transformers;
J1 and J2—double-circuit jacks;
J3—single-circuit jack;
C—mica fixed condenser, .0005 mfd.;
R2 and R3—filament rheostats;
extra "B" batteries, 67½ volts.

* * *

QUESTION: Will a variable grid leak be better in the four-circuit tuner than the fixed grid leak of two megohms? Will it make the set any more sensitive or is it unnecessary? Before I had my four-circuit set I used a honeycomb receiver and the variable grid leak helped me considerably.

A. V. McCOOMBS

ANSWER: The variable grid leak (if it is a good one) should help if it is connected across from the grid to the negative "A" battery terminal.

QUESTION: I have a single-tube Reinartz receiver, to which I want to add two stages of audio-frequency amplification. I am at present using a UV-200 detector tube and am undecided as to what kind of tube to use for the amplifiers. I have a storage battery that is capable of handling almost any type of tubes, I am told, so I would be obliged if you will tell me which are the best to use, taking into consideration the results, battery load, and operating life.

J. FENNEL

ANSWER: In the October, 1923, issue of POPULAR RADIO you will find an article that gives full instructions showing how to build a two-stage audio-frequency amplifier. This will give you ample details on both the construction and operation of the device. You may use UV-201-a tubes in the amplifier with fine results and with little drain on your batteries. These tubes draw but a quarter of an ampere.

* * *

QUESTION: Will a vernier rheostat help any in controlling regeneration in conjunction with a UV-200 detector tube in a twin variometer-variocoupler regenerative receiver?

K. F.

ANSWER: Yes. Either a wire rheostat with a vernier attachment or one of the reliable makes of carbon-pile rheostats will help considerably.

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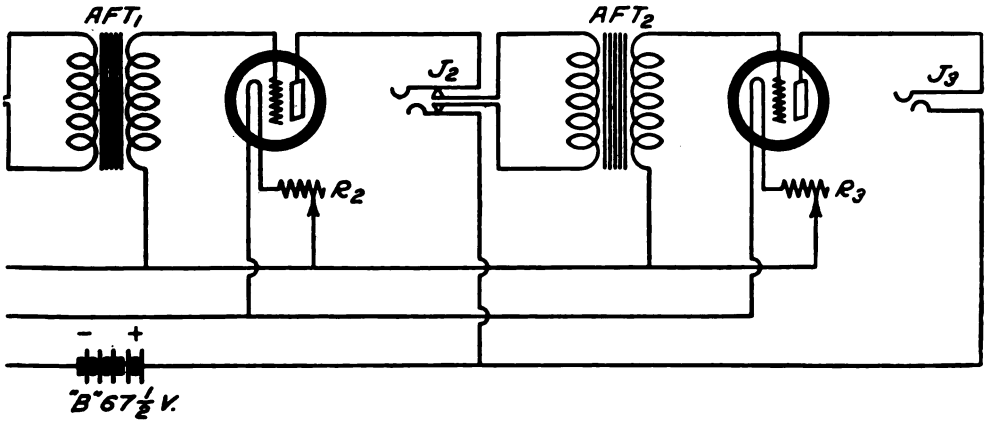
FIGURE 2: *This diagram shows how to add two stages of audio-frequency amplification to the triple-coil regenerative receiver. This will allow of loudspeaker reception of local broadcasting and from out-of-town stations up to 1,000 miles.*



QUESTION: What is the ordinary capacity range for fixed condensers used in the grid circuits of detector tubes? What is the capacity that would be the best average to use?

GEO. BRUHN

ANSWER: Grid circuits usually employ a condenser (for isolating the grid) of between .0001 and .00075 mfd. capacity. Any value between these two values will give good results. The most used capacity value, nowadays, is about .00025 mfd.

* * *

QUESTION: Are refilled tubes, that have had the filaments repaired any good? I have a number of old tubes with the filaments burned out and I have been considering the advisability of getting them repaired.

H. ANDREW BROWN

ANSWER: If the filament material which is replaced is of the same type and characteristics as the original, and the degree of vacuum repumped the same as when manufactured, the tube will be just as good. It is a question, however, whether a repair company can do this with all makes of tubes.

* * *

QUESTION: What materials and instruments should I have to make a good soldering job?

A. H. STEARNS

ANSWER: You will need a reliable electric soldering iron (about ½-pound size), a soldering-iron stand, some strip solder, a good grade of soldering paste, some alcohol, and a clean piece of cloth.

The alcohol and the cloth should be used, after the pieces have been soldered together, to clean off any excess soldering paste that may have run around the joint.

* * *

QUESTION: What will give the least hum when used as a voltage supply for a small transmitting radio telephone? I intend to use either an AC power transformer with chemical rectifiers and a filter or a motor generator with a filter. Which shall I use? I don't want to have any hum at all when the voice is used for transmitting.

GEORGE STAVERS

ANSWER: The motor generator and the filter will give the least hum. When you get the generator you can also write to the company that manufactures the apparatus and they will furnish you with the necessary data on the filter system to be used with it.

* * *

QUESTION: What is the least number of tubes to use in a super-heterodyne and still get some benefit out of this mode of amplification at a radio frequency?

K. G.

ANSWER: Not less than six tubes.

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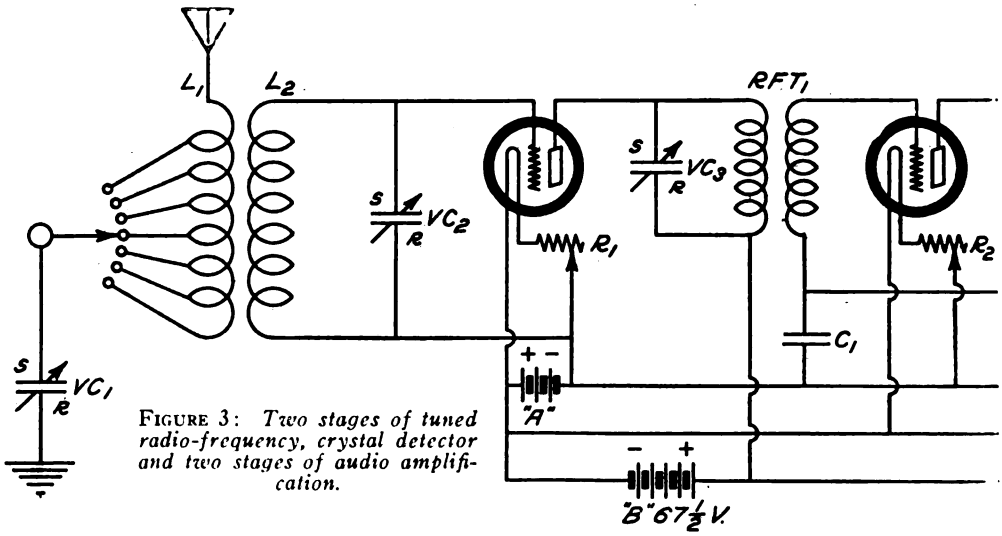

FIGURE 3: *Two stages of tuned radio-frequency, crystal detector and two stages of audio amplification.*

QUESTION: Will you please give me the wiring diagram for two stages of tuned radio-frequency amplification, crystal detector, and two stages of audio-frequency amplification, with the least number of tubes that will be practical. This will mean, I believe, that the reflex principle will have to be used. I have an Amertran and a new Federal transformer; will these be suitable? I also would like to use spiderweb or honeycomb coils for coupling the radio-frequency stages if possible. How many variable condensers will I have to use?

ARTHUR F. BATES

ANSWER: The diagram shown in Figure 3 shows how to connect up the instruments that we advise using. This circuit includes two stages of radio-frequency amplification, crystal detector, with one stage of audio-frequency amplificatoin reflexed on the second radio-frequency stage, and one stage of audio added to the whole. This set-up uses only three tubes.

The parts you will require are the following:

L1 and L2—primary and secondary coils of a regular 180° variocoupler;

RFT1 and RFT2—coupler-coil sets, each made up of two honeycomb coils, size L-50, mounted in a double-coil mounting;

VC1—variable condenser, .001 mfd.;

VC2, VC3, and VC4—variable condensers, .0005 mfd.;

C1, C2, and C3—mica fixed condensers, .001 mfd.;

R1, R2, and R3—filament rheostats, (resistance to suit tubes used);

DET—crystal detector.

The two transformers you have mentioned will be suitable for the audio-frequency transformers shown on the diagram at AFT1, and AFT2, respectively.

* * *

QUESTION: Would a large horizontal loop wound around the top of the square roof of my house work? The house is of wooden construction and I could set the wires out from the edges on insulators.

GEORGE MARX

ANSWER: This would work if the inductance was of the correct value for the wavelength range that you want to receive on. All you would need for tuning would be a variable condenser shunted across the two terminals of the loop. You could determine the correct number of turns to use by trying, say, two or three turns and then reducing the number of turns one at a time until you found the correct number. You might try this out at first, with bell wire and then when you find the correct number of turns to use, you could put in a permanent installation of good antenna wire.

* * *

QUESTION: Where can I obtain a license to manufacture regenerative receiving sets to sell to amateurs? I understand that this invention is patented by Armstrong.

A. C. D.

ANSWER: The patents on the regenerative receiver are controlled by the Westinghouse Company and the Radio Corporation. We understand that they are not issuing any further licenses for the manufacture of this type of receiver.

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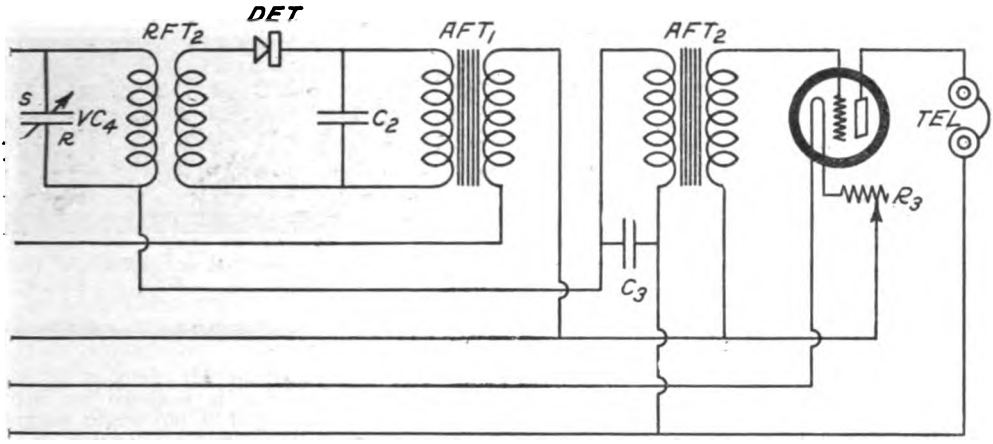


QUESTION: I want to get the simplest reflex hook-up that will give me results with one tube and a crystal detector. The hook-up should contain the smallest number of parts and the tuning should be done as simply as possible.

HAROLD V. B. STENTON

ANSWER: The simplest circuit that we know of that will be productive of satisfactory results is shown in Figure 4. Parts needed are:

VAR—variometer;
C1—mica fixed condenser, .0001 mfd.;
C2—mica fixed condenser, .00025 mfd.;
C3—mica fixed condenser, .0005 mfd.;
C4—mica fixed condenser, .001 mfd.;
C5—mica fixed condenser, .001 mfd.;
VC—variable condenser, .0005 mfd.;
RFT—two honeycomb coils, size L-50;
DET—crystal detector;
TEL—telephones;
Suitable vacuum tube, "A" and "B" batteries.

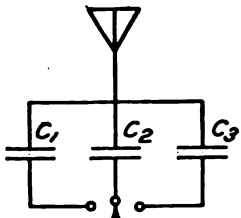
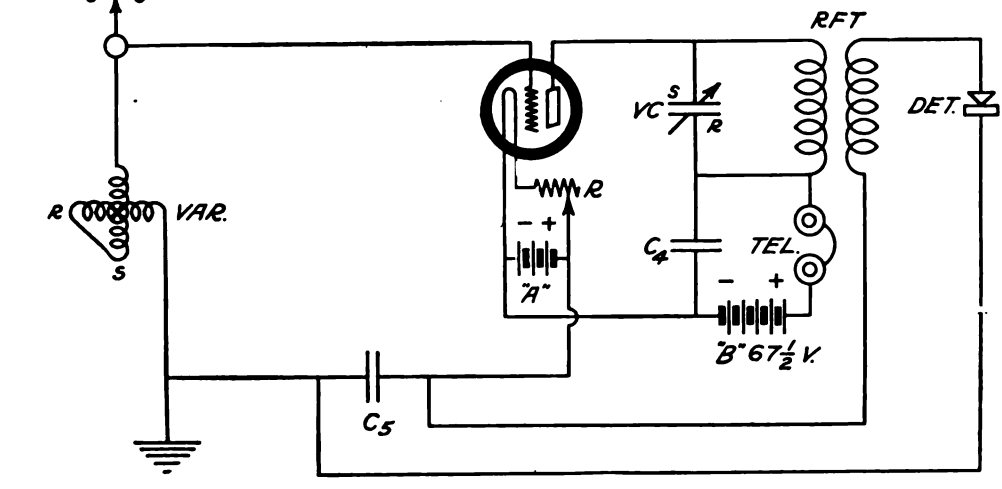


FIGURE 4: *A simple reflex set without an audio-frequency transformer.*

It will be noticed that there is no audio-frequency transformer used in this circuit; the rectified currents from the crystal detector being reflexed back across the fixed condenser C5 which is included directly in the grid circuit of the tube. This and the fact that two honeycomb coils are used in place of the ordinary radio-frequency transformer makes the set inexpensive.

The condenser VC is used to tune the plate circuit of the tube at a radio frequency. Antenna tuning is done, roughly, by placing the switch on either of the three condensers C1, C2, or C3, which brings in the loudest signals when VAR is rotated to the correct setting.



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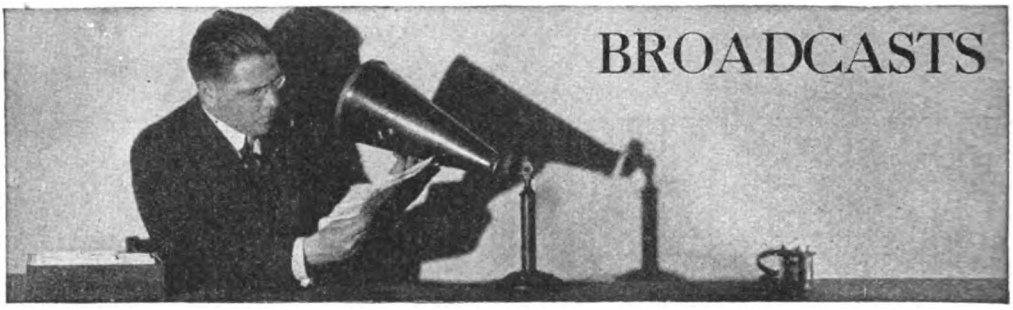

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

Radio Reception from the Doorbell Wiring

ALMOST anything will serve as an aerial if you have nothing else. Bedsprings, the kitchen stove, a string of cooking pots fastened together and hung on a line, the wire framework of grandmother's ancient bustle, all these and many more have joined the freak aerial list. A less freakish one that often is really useful is the wiring of the front doorbell. Either side of the line may be used and if the connection is made through a condenser there is no interference with the proper use of the bell circuit.

* * *

Blind Listener to Check Up on Broadcasting

WHAT may prove to be an important and remunerative occupation for the blind is forecast by the appointment of Miss Marjory Stewart, who is blind, as official critic on the staff of WBZ. It is well known that blind persons acquire an unusual delicacy of hearing. Judgment of purity of tone and precision of modulation ought to be better in the sightless than in ordinary people. As we have already professional tea-tasters and coffee-smellers whose income depends on especial delicacy of these senses so we may have before long a profession of expert listeners whose duty it will be to detect and report the minor faults of broadcasting quality.

* * *

Communicating with Mars by Radio Photographs

MR. CHARLES MACLEAN, the genial editor of the *Popular Magazine*, amuses himself with some reflections as to how we would make the Martians understand us even if we succeeded, by radio or otherwise, in communicating with our sister planet. Why not, he suggests, try the radio photograph? We can transmit pictures by radio; so, presumably, can the Martians. Following the example of the child's picture book we could send a picture of a cat and accompany it by the appropriate sound, which might be, we suppose, either "kat" or "meeow." Of course, this does not explain how we are to transport the necessary receiving apparatus to Mars, the Martians having failed, one imagines, to develop the exact equivalent of Mr. Jenkins or Dr. Belin. But when one is engaged in interplanetary speculations it is unkind to suggest minor experimental difficulties like this.

* * *

Broadcasting a Heartbeat

MAGNIFYING the sound of the beating heart so that it can be heard loudly all over a large lecture room, is the latest radio stunt of Dr. Richard Cabot, a well-known Boston physician. Vacuum tube amplifiers are used, the object being to demonstrate to medical students the slight variations of the heart sounds that indicate certain diseased conditions. All the students can hear exactly the same sound at the same time and the instructor can explain just what it means.

* * *

Attracting Attention to an S. O. S.

SINCE not all ships at sea can have a radio operator actually at the listening set every moment day and night, a French inventor has devised a relay apparatus that will operate automatically on the receipt of the series of three dots, three dashes and three dots that constitutes the distress signal. This relay will then operate a bell or other signal that secures the immediate attention of the radio operator or other officer of the ship. The same device could be installed on shore stations, as, for example, in lighthouses and coast-guard stations.

* * *

Sherlock Holmes Takes Watts Instead of Watson

SCOTLAND YARD, the famous center of British police work, is to install two 500-watt transmitter units so that criminal news can be broadcast to the outlying police stations and to affiliated agencies in the provinces. An automobile has been equipped with another set so that officers in the field can keep in touch with the central office. We shall look for some new detective stories in which ether waves replace the footprints and chemical tests of the days when the famous Sherlock lived in Baker Street with the equally famous doctor.

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Why Does Sunlight Help a Crystal Detector?

ONE of the most mysterious phenomena in the whole of radio science is the familiar crystal detector. Nobody knows, for example, why it is that a crystal will pass the current in one direction and refuse to pass it in the other. Another mystery is the effect of light on crystals. Most crystals will work better if a strong light, like sunlight condensed by a burning glass or the light of a powerful tungsten lamp, is focussed upon them. Galena behaves in this way and so do most samples of pyrite. Other pyrite crystals do not seem to be affected. Carborundum and the tellurium mixtures seem, also, to be unchanged when strongly illuminated. But everything in this field is uncertain and needs more precise scientific investigation. Any radio amateur has a good chance of making important contributions to radio science if he will work out carefully the behavior of known varieties of crystals under different conditions of light, temperature, electric potential and the like.

A $10.00 crystal set and a dollar's worth of extra crystals may serve to put your name in the radio textbooks if you have patience and skill enough.

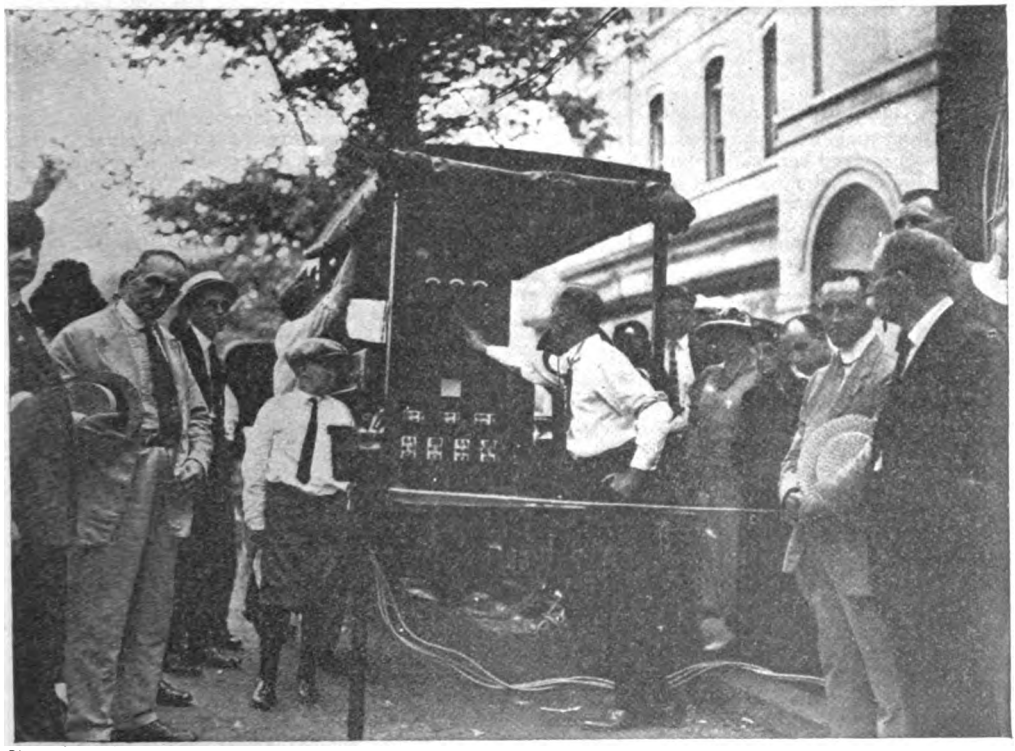
A Curious Coincidence in Broadcasting Explained

A RADIO listener at Providence, R. I., announces that recently he heard the same selection being broadcast at the same time and in the same key and tempo from two separate stations. A mathematical expert reports that the chances against such an occurrence, assuming that there are at the moment one hundred musical selections of equal popularity and equally likely to be selected for broadcasting, are more than sixteen billion to one. What this fan really heard was the simultaneous broadcasting of a program, via telephone wires, from stations WEAF and WCAP.

* * *

Hunting Radio Needles in a Busy Haystack

A NEW radio game that anyone can play was invented as a part of the amusement program at the recent Chicago convention of the American Radio Relay League. Somewhere in the city a secret transmitting station was concealed. Players were provided with small loop receiving sets. The game was to locate the secret station by direction bearings taken with the small loops and then trace it down and find it.



Kadel & Herbert

A BROADCASTING STATION ON WHEELS

This interesting novelty is maintained by the Chesapeake & Potomac Telephone Co. for the purpose of enabling station WCAP to broadcast occasions of interest direct from the scene; the truck covers the entire area of the District of Columbia. It is here shown broadcasting the funeral services of President Harding direct from the church.

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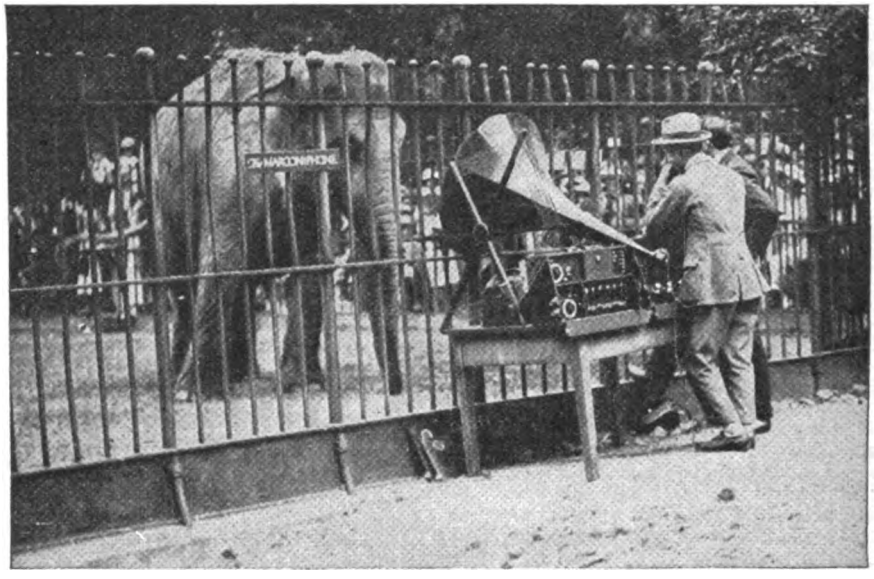

A LONDON ELEPHANT GETS COMMANDS BY RADIO FROM—

In an interesting experiment recently, at the London Zoo, this trained elephant was given orders that were broadcast by radio, his master speaking from a broadcasting station miles away. Perhaps the loudspeaker distorted the familiar accents; anyway, the elephant was skeptical and refused to perform.

Watch Tick Breaks Up Bishop's Speech

IT is unusual to find your enjoyment of the sermon marred because the minister's watch ticks so loudly that you cannot hear his words. Yet that is what happened recently when Bishop W. F. McDowell was broadcasting a sermon by radio. He inadvertently placed his watch close to the microphone and its ticks were magnified so loudly that many listeners complained of inability to hear what the Bishop was talking about.

* * *

Will Radio Make Plants Grow Faster?

EXPERIMENTS indicating that the growth of plants is hastened by high-frequency electric currents have been reported recently by several separate investigators. Currents were used, not waves; whether actual radio waves will have similar effects remains to be investigated.

* * *

Finding Engine Troubles With a Radio Amplifier

A NOVEL use for radio has been discovered by a British mechanical engineer. It is well known that the very beginnings of trouble with large rotating machinery, like high-power steam turbines or high-speed dynamos, is indicated by a slight change in the humming sound given out by the machine. Experienced engineers have been accustomed to press an ear now and then against shaft-hangers that they suspected of being not quite true or against bearings that showed signs of trying to get hot. Now this listening is being done by radio. A small microphone is pressed against the suspected machine. Amplifiers increase the sound so that the faintest beginning of an abnormal chatter can be detected at once. It is suggested that permanent microphones may be installed attached to important machines or bearings, as, for example, to the vital parts of marine engines. These can be connected by wires to an amplifier and a telephone in the office of the chief engineer. By plugging in for each microphone in turn this official can keep a continual eye, or rather an ear, on all the machinery under his charge.

* * *

Sound Waves of Radio Frequency

SOUND waves of frequencies so high as to be inaudible have been produced in France and used in scientific experiments. Though these waves are in air or water, not in the ether, they are well within the frequency range of radio waves.

* * *

Another Battleship To Be Equipped With Radio Control

THE United States battleship, *North Dakota*, built in 1910 and now due to be scrapped under the disarmament treaty, is to be equipped with radio control and used in gunfire and bomb tests as the *Iowa* was last year. The cost of the ship was over $7,000,000 and it is estimated that $100,000 or more will be spent in refitting the ship for target use and in adding the apparatus for radio control. But the cost is felt to be justified by the information obtainable concerning the resisting power of armor plates and the effects of modern airplane bombs and

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—HIS TRAINER, MILES DISTANT

This is Syed Ali, the Indian trainer of the elephant shown on the opposite page, broadcasting his command from Station 2LO in London.

high-power shells. Further valuable information will be acquired, we imagine, concerning the methods of controlling machinery of such bulk and complexity by radio signals.

* * *

Taking Congress to the Public

The Chamber of Deputies of the Argentine Republic (corresponding to our Congress) has taken steps to make the public listen to their proceedings whether the public wants to do so or not. A broadcasting station has been installed in the chamber at Buenos Aires in which the Deputies meet. Debates are broadcast and trucks equipped with receiving sets and loud-speakers are stationed from point to point around the city to pick up these debates and pour them into the ears of such of the citizens as chance to be on the streets.

* * *

Amateurs Asked to Help Radio Test

A TEST suggested some time ago by Mr. Thomas A. Edison is to be carried out by the Aerial League of America. Mr. Henry Woodhouse, President of the League, asks radio amateurs all over the world to co-operate during the present winter in keeping regular daily records of radio reception at their stations, including signal strength, direction of the wave and, if possible, any accompanying magnetic conditions such as the aurora. Prizes are offered for the best report. Information can be obtained from the Aerial League of America, 280 Madison Ave., New York City.

* * *

Sound Waves from Explosions Fade Like Radio Signals

RECENT experiments in Holland indicate that the sound wave going out from a great explosion shows phenomena of "dead spots" and "fading" the same as are exhibited by radio waves. The theory for this behavior of sound is still a mystery.

* * *

Is "Fading" Caused by City Smoke?

COMPLICATED fading phenomena which have been causing trouble with broadcast reception in the neighborhood of London may be due, it is suggested, to the increased conductivity imparted by smoke particles to the air over the city.

* * *

Radio to Call the Car for You

IF a recent suggestion of Dr. De Forest is adopted, the calling of automobiles for patrons of theaters and concert halls may be done by radio. The present systems of luminous number signals may go into the discard to join the former megaphone man who used to bawl out totally unintelligible numbers over the heads of the after-theater crowds. Each automobile might be equipped, Dr. De Forest suggests, with a small receiving set working on a loop. A tuned transmitting set could be installed at the theater exit. The man in charge of this transmitter would merely speak into it saying, for example, "Mrs. Jones' car is wanted at the side exit." All the waiting chauffeurs would be listening, even if they were around the corner out of sight or in a nearby garage. Mrs. Jones' car would arrive exactly where she wanted it much more quickly than is possible under any present system.

* * *

Will Three-foot Waves Prove Practical?

EXPERIMENTERS in England are now working with transmission of signals over radio waves as short as one meter. These very short waves have been produced previously in laboratories but have had only a scientific interest.

* * *

Radio Lighthouses Grow in Favor

EXPERIENCE with the revolving radio lighthouse at Inchkeith has been so successful that two new stations on the same system are to be erected by the British Government.

* * *

A Short-wave Broadcasting Station

A NEW short-wave broadcasting station has been opened at Christiania, Norway. It transmits on a wavelength of 390 meters, the shortest wave in use so far on the Continent of Europe.

¶ IN *the next issue of* POPULAR RADIO—*for February—will appear a short article by Mr. Laurence M. Cockaday that will tell how to add to the Four-circuit Tuner described in May, 1923, to include the improvements contained in the article on page 23 of this number.*

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Important Vibrations Even Below Audio Frequency

THERE is a new profession, the vibration engineer. He is the man who studies and stops the annoying vibrations sometimes set up in steel buildings by machinery or other causes. Most of these vibrations are below the frequency of 30 or 40 vibrations a second, which is the lower limit of audible sound. Otherwise they are just like sound vibrations. The detector that the vibration engineer uses is a special form of seismograph, a modification of the instrument used to record earthquakes. The characteristics of these infra-audio vibrations, their resonance and interference and the like, are much the same as those of other vibrations. It is probable that the increased study of vibrations in general which has resulted from the advance of radio will assist the control and prevention of these mechanical vibrations as well. One branch of science sometimes proves of unexpected value to other branches. Radio has been no exception. It is already of the greatest service to many other sciences, as was pointed out by General Ferrié in the October number of POPULAR RADIO.

* * *

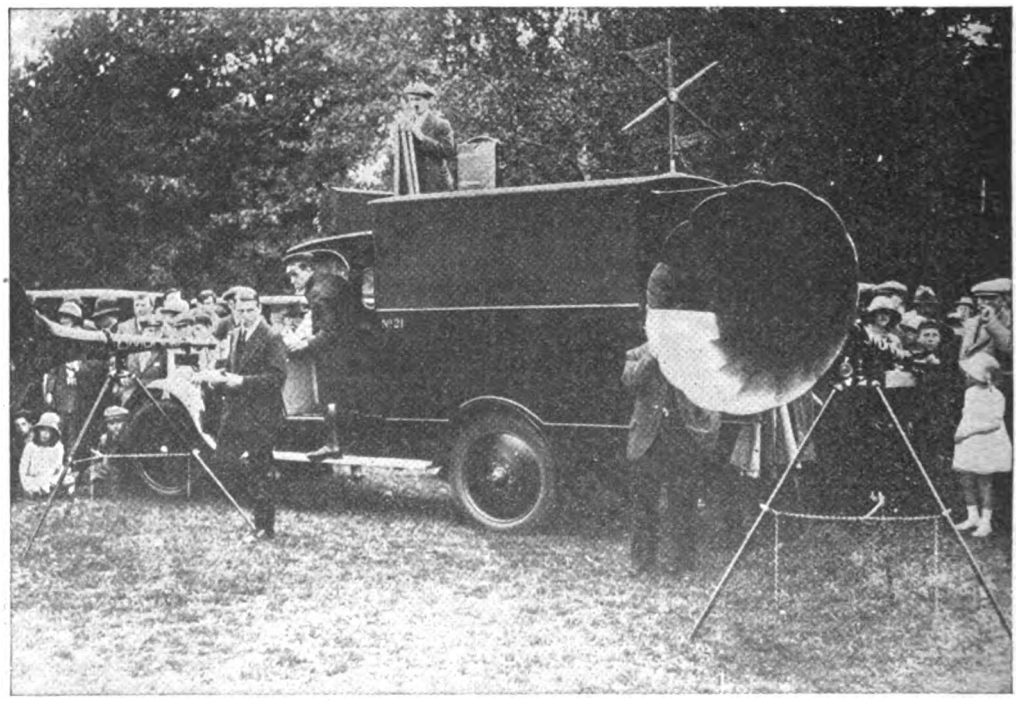
More Radio in the Arctic

RECEIVING sets are to be distributed to the men in charge of the Hudson Bay Company in northern Canada and elsewhere in the arctic where the posts are snowed in and communication is impossible all winter. It is hoped that broadcast concerts from the United States can be received and will help to pass the long winter nights for the men who have to live in these inhospitable regions. It is probable, also, that a good deal of information will be obtained concerning radio transmission in the arctic and in the neighborhood of the magnetic pole, and concerning the relations between radio transmission and the electromagnetic phenomena that accompany the Aurora, some problems of great scientific interest that are discussed by Mr. Henry Woodhouse in this number of POPULAR RADIO.

* * *

The Flood of Radio Literature

ACCORDING to a count made by the exchange department of POPULAR RADIO there are now being published in the world 61 magazines devoted exclusively to radio. Of these 38 are in English. This count does not include about fifty periodicals that devote departments or special articles to radio nor does it take account of some two hundred newspapers, here and abroad, that have radio pages, columns or departments. It is safe to say that well over 400 separate radio publications are issued in the world each month.



International

A UNIQUE "RADIO PICNIC"

On this motor truck are mounted a powerful receiving set with huge loudspeakers and a loop antenna. When the Junior Oar Club recently held an outdoor festival at Burnham Beeches, England, this apparatus was used for picking up programs broadcast from the European stations, for the wholesale entertainment of its guests.

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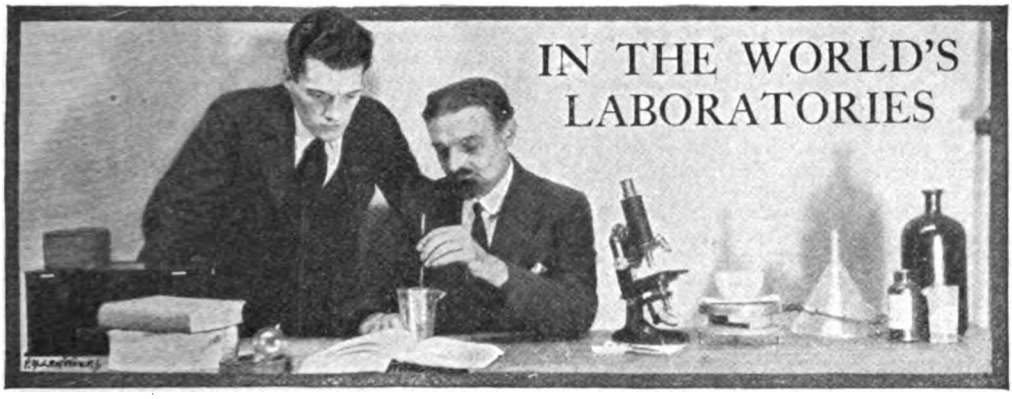

Shaking the Earth by Radio Power

THE often-quoted idea that the earth as a whole might be set into electric oscillations of high frequency, with valuable consequences for mankind, has been revived with greater scientific authority than ever before through a recent article of Mr. Leon Bouthillon, chief engineer in the telegraph service of the French Government.[1]

The idea itself is not unfamiliar to radio engineers. An antenna can be set into regular electric vibrations by any source of high-frequency oscillations and each antenna has, of course, its own "natural" frequency at which it will oscillate, if untuned by condensers or otherwise and if left to itself. The whole earth can be considered as such an antenna, or (to make the analogy more evident) the earth may be considered as a ball attached to the end of an oscillating antenna. Metallic balls like this, attached to wires, were used, in fact, in the early radio experiments of the great Italian physicist Righi, the scientific instructor of Marconi.

The earth, considered thus as an antenna, has, of course, its own natural frequency. It is, says Mr. Bouthillon, about six cycles a second, corresponding to a wave of 50,000,000 meters or approximately 31,000 miles. There is every reason to believe that the earth, once set into electric vibrations at this natural frequency, would continue to oscillate at the same frequency until the energy of the oscillation was extracted artificially or dissipated itself in some accidental way.

The practical possibilities depend, obviously, upon how fast the energy would be so dissipated. It might be absorbed rather rapidly by eddy currents in the rocks or in the ocean. It might come somehow into conflict with energy or material being received continually from the sun or from space. How effective these energy-absorbing factors might be cannot be foreseen.

But suppose they should prove, as is possible, to be comparatively ineffective. Suppose the earth should prove to be tunable, so that its oscillations would continue indefinitely at the same period. If these things should prove to be the case (and no one can assert that they are not) we would be possessed, says Mr. Bouthillon, of a new and remarkably effective way of transmitting power. Great power stations at favorable points, such as Niagara or the tremendous falls of Africa, now unused, would feed their energy into the oscillating earth in the form of currents at the natural frequency of six cycles a second. Tuned receivers anywhere on the earth could extract this energy at the same frequency, just as a radio receiver extracts the energy of a radio wave to which it is tuned.

The possibilities are alluring but it is too soon, as Mr. Bouthillon is careful to point out, to regard them as practicabilities. The vistas opened into the possible future do reinforce, however, the urgency of making accurate and comprehensive scientific studies of the electrical properties of the earth.

1. "Anticipations Concerning the Transmission of Energy to a Distance," by Leon Bouthillon. *Radio-Électricité*, Vol. 4, pages 397-400 (October 1, 1923).

Two Waves Work Better than One

A NEW radio system that is suitable for radiophone work or for use with CW code signals has been described by Mr. Howard J. Tyzzer.[1] It depends upon the use of a doubly modulated wave.

Suppose the primary wave is 300 meters. On top of this there is produced a continuous modulation at another frequency that is much lower than the frequency of the primary wave, corresponding (say) to a wavelength of 5,000 meters. This second or superposed frequency, which is still well above audible frequency, is soundless. The interruptions that correspond to code signals or the fluctuations (within audio frequencies) that correspond to the voice are then superposed by a second modulation upon the first, or 5,000 meter, modulation.

The advantage claimed for this system is that the receiving set can be tuned, in effect,

1. "A New Radio System," by Howard J. Tyzzer. *QST*, Vol. 7, No. 3, pages 15-18 (October, 1923).

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for two separate frequencies, that of the primary wave (300 meters) and that of the continuously modulated wave (5,000 meters). This removes most of the interference and atmospherics, as only those interfering impulses that coincide with *both* of these critical frequencies will pass the doubly tuned filter mechanism of the receiving set. It is even possible, Mr. Tyzzer states, for two stations to transmit on the same primary wave (300 meters) without interference provided they use different superposed modulation frequencies; one, say, at 5,000 meters, the other at 6,000 meters.

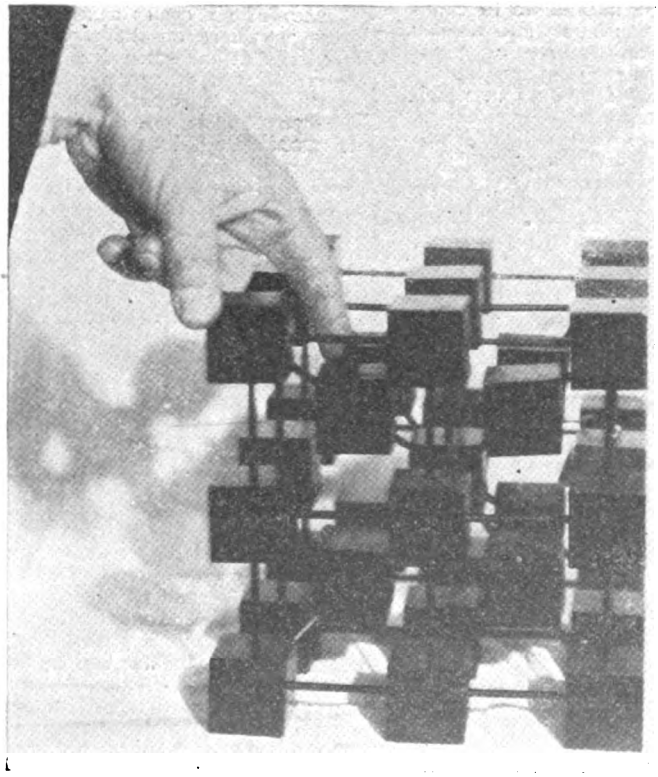
Details of the necessary hook-ups are given in the article in *QST* and Mr. Tyzzer announces his willingness to supply further information to amateurs who are desirous of experimenting with this system. He may be addressed at the American Radio and Research Corporation, Medford Hillside, Mass.

Man Is Made of Electricity

FEW scientific events of 1923 have attracted more attention, from scientist and layman alike, than the presidential address of Sir Ernest Rutherford at the recent meeting of the British Association for the Advancement of Science, delivered at Liverpool, England, on September 12. Sir Ernest's subject was no less than the basic substance of which everything in the material universe is built. This fundamental substance, he said, is electricity. The earth under our feet, the stars over our heads, the structures of the human body, even that mysterious organ, the brain, that embodies what we call the human mind; all of these consist, in the last analysis, of electricity and of nothing else.

Sir Ernest Rutherford has long been a leader among the scientists who have been experimenting on the ultimate structure of matter. He it is who accomplished recently the age-long dream of the alchemists and succeeded in transmuting one kind of matter into another kind. Conjointly with Dr. Chadwick he succeeded, in fact, in transmuting six different kinds of matter. The atoms of nitrogen, boron, sodium, fluorine, phosphorus and aluminum were disintegrated in these famous experiments and were made to yield, among other things, new atoms of hydrogen.

In his Liverpool address Sir Ernest reviewed the information that has been won from these and other experiments. He pictured vividly the modern conception of what



American Chemical Society

THE SKELETON IN A PIECE OF IRON

The little wooden blocks of this model are arranged in the same positions as the central electric charges in the atoms of metallic iron.

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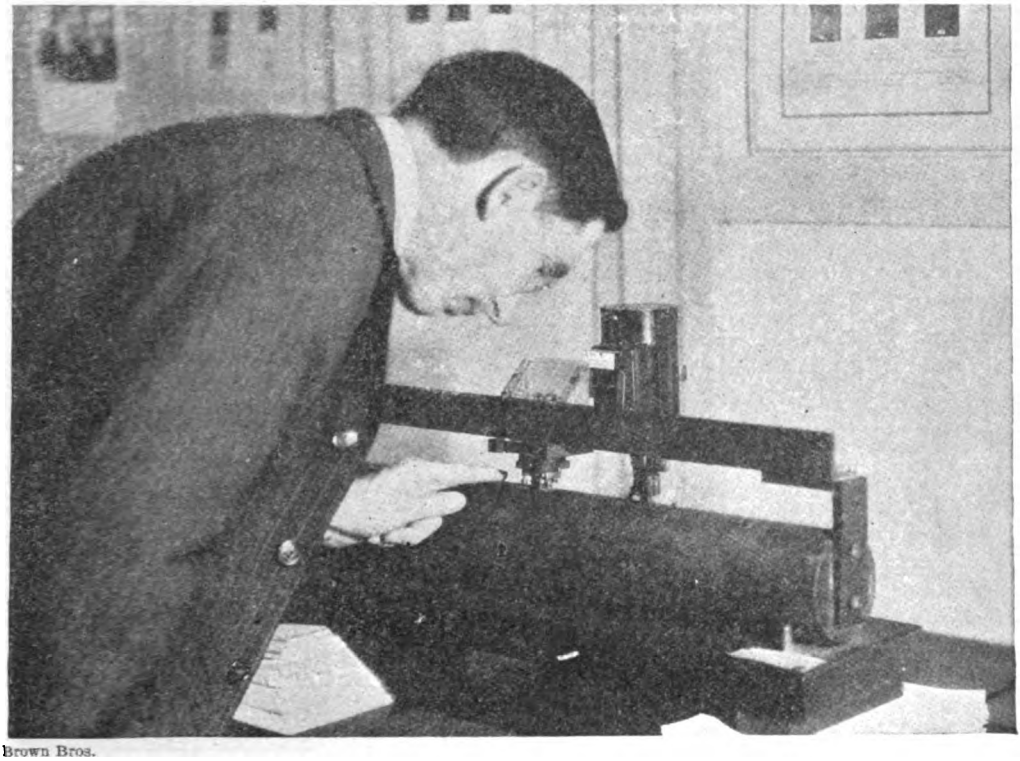

Brown Bros.

WEIGHT OF A FINGER BENDS THREE-INCH IRON BAR

This apparatus developed by the United States Bureau of Standards demonstrates the extreme accuracy with which measurements can be made by using light waves. The weight of the finger bends the bar enough to be easily perceptible.

an atom of matter is. It is entirely an electrical conception.

The simplest known atom is the atom of hydrogen. At the center of this atom there is a particle of positive electricity. Revolving around this central particle, in an orbit not unlike the orbit of our earth around the sun, is another particle, this time a particle of negative electricity. This outer, planetary particle is, in fact, nothing else than the familiar electron. That is all there is to the hydrogen atom. It is all electricity; a particle of positive electricity at the center and a negative electron revolving in an orbit around it.

This is, of course, the simplest atom. It has only one particle of each kind. But other kinds of atoms, those of iron or copper or radium or any of the other elements, are composed of these same particles only there are more of them. "There is," says Sir Ernest, "the strongest evidence that the atoms of matter are built up of these two electric units, *viz.*, the electron and the hydrogen nucleus or proton, as it is usually called when it forms part of the structure of any atom. It is probable that these two are the fundamental and indivisable units which build up our universe, but we may reserve in our mind the possibility that further inquiry may some day show that these units are complex, and divisible into even more fundamental entities.

"On the views we have outlined the mass of the atom is the sum of the electrical masses of the individual charged units composing its structure, and there is no need to assume that any other kind of mass exists. At the same time, it is to be borne in mind that the actual mass of an atom may be somewhat less than the sum of the masses of component positive and negative electrons when in the free state. On account of the very close proximity of the charged units in the nucleus of an atom, and the consequent disturbance of the electric and magnetic field surrounding them, such a decrease of mass is to be anticipated on general theoretical grounds."

The attainment, in the past fifteen years, of this revolutionary and yet extremely simple conception of how the ground-stuff of the universe is made up must rank, Sir Ernest believes, among the most far-reaching of scientific achievements, an achievement for which he modestly gives most of the credit to others.

He is hopeful, too, that the progress of these fundamental investigations will continue, that discoveries of still greater moment are on the way. "There appears to be," he says, "no obvious sign that this period of great advances

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has come to an end. There has never been a time when the enthusiasm of the scientific workers was greater, or when there was a more hopeful feeling that great advances were imminent."

Testing the Einstein Theory with a Tile Pipe

WHEN Professor Einstein announced his famous theory he described three consequences, commonly called "proofs," of it. They were, *first;* the change in the orbit of the planet Mercury, unexplained by the ordinary theories; *second;* the bending of light rays from the stars as the rays pass close to the sun, and, *third;* a slight displacement of the spectrum lines in sunlight as compared with the same lines produced on earth.

Careful efforts to detect this third effect[1] have failed until this year, but at the meeting of the American Association for the Advancement of Science at Los Angeles in September, Dr. Charles E. St. John of Mount Wilson Observatory announced that he and his associates had finally succeeded in measuring the crucial spectrum lines with the requisite degree of precision. The results are confirmatory of the Einstein Theory, which marks another triumph for the theory and another step, presumably, toward its general acceptance by physicists.

Meanwhile Professor Albert A. Michelson of the University of Chicago (who devised the apparatus a year or two ago by which the size of the giant star Betelgeuse was measured) is planning still another test of the whole Einstein point of view. Jointly with Professor Henry G. Gale of the same university, Professor Michelson is installing a two-foot tile pipe across the military drill-ground used by the students. By apparatus in this pipe, the two professors will attempt preliminary experiments to determine whether or not there really is an ether which the earth drags with it as it rolls along through space. This is the same problem that was attacked by Professor Michelson and Dr. Morley many years ago in the famous experiment known by their names and which experiment led, when it failed to detect the ether, to the fundamental assumptions of the Einstein Theory.

If the new experiment comes out the same as the earlier one the Einstein Theory will be left undisturbed. But if this repeated attempt to detect the real existence of the ether should happen to succeed, Professor Einstein will have some difficulty in explaining it away.

In spite of great preparations, probably the greatest ever made by the scientific professions for a similar event, the eclipse of the sun that occurred in September was a scientific failure. The weather of Southern California, which in spite of the insistency with which it is advertised, is really admirable, proved for once to be fickle. Rain at this time of the year is almost unknown in Los Angeles but this year it occurred and it picked out the very day and minute of the eclipse. Everytl ing was obscured by clouds and no scientific results were obtained. A few photographs of the corona were obtained by a small expedition a little farther north, at Lompoc, California, and some results are reported from the Mexican expeditions. Apparently, however, no further information bearing on the Einstein Theory was obtained.

Another piece of news concerning the theory is that the allegations of plagiarism recently made against Professor Einstein have been disproved. Dr. Robert Trumpler, writing in a recent number of *Science* (New York) reports that he has examined the original paper of the long-dead mathematician, Soldner, from whom Einstein was alleged to have "borrowed" his value for the bending of light as it passes the sun.

The early astronomer did obtain, Dr. Trumpler reports, a value for the bending which is numerically almost the same as Einstein's value. But this result was accidental. Soldner made a mistake in his figures and this mistake made his result come out right though his theory was wrong. His work was in no sense an anticipation of the Einstein ideas.

1. See POPULAR RADIO for November, page 410.

Radio Better During the Eclipse of the Sun

ALTHOUGH the attempt of the astronomers to secure new photographs of the solar eclipse were so largely unsuccessful, the radio experts were more fortunate. Measurements of the signal strength of KHJ, Los Angeles, before, during and after the eclipse were obtained at a number of stations located in Southern California and in Mexico within the band of total darkness.

The results, so far as they have been collected and studied, seem to indicate that the effect of the eclipse was indistinguishable from the effect of normal night-time darkness. Signal strength increased as soon as the shadow of the sun arrived, exactly as it does normally at sunset. As soon as the eclipse was over the signal strength decreased as it does at daybreak. Both the increase and the decrease were proportional, so far as could be determined, to the fading and brightening of the light itself.

It would seem, therefore, that the effect of the sun upon radio transmission, however this effect is produced, must be closely related either to the sunlight itself or to some other ray which travels through space with exactly the velocity of light. Were we to ascribe the radio differences between night and day to electrons or any other kind of material particles shot out from the sun we would expect a lag between the beginning of the eclipse as marked by the diminution of sunlight and the onset of the changes in radio transmission. No material particles could be expected to move through space with *exactly* the velocity of light, though they might approach it.

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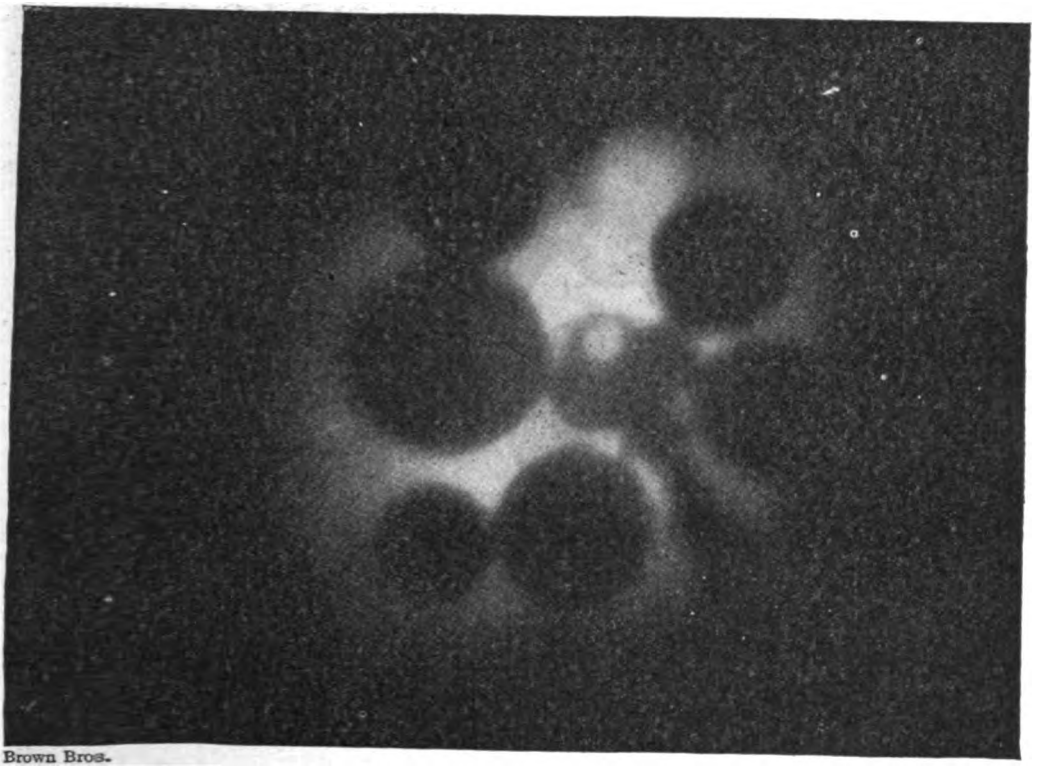

Brown Bros.

A PHOTOGRAPH MADE BY RADIUM

These coins and key, wrapped in light-tight black paper, were photographed by the rays from a tiny quantity of radium, just as though the black paper had not been there. These same radium rays can be made to operate a vacuum tube such as is commonly used in radio.

Can We Make Vacuum Tubes Out of Radium?

THERE are so many newspaper reports of new radium filaments and of radio-active vacuum tubes that it is worth while to see just what the possibilities are in this direction.

Radium gives out, among other things, a continual stream of electrons. A filament of metallic radium in a vacuum tube would produce electrons continuously, whether it were hot or cold, for thousands of years. It would avoid, therefore, any necessity of heating the filament. The heating battery could be dispensed with and the filament would never wear out or burn out.

This would be very pleasant, but filaments of metallic radium are impossible if for no other reason than because one of them would cost some half-million dollars. What is actually proposed and has been many times attempted is to construct a tube in which the hot filament as a source of electrons is replaced by a preparation containing a very little radium but which is still capable of giving off a continual stream of electrons. A familiar example is the material used in the face figures of the so-called radium watch. This material really does contain a little radium. The activity of the radium produces light from another constituent of the material and that is why the figures shine in the dark.

Now similar compositions containing radium can be made so that they will produce electrons instead of light and they can be put into vacuum tubes instead of the filament. A radium tube is, therefore, possible in theory. It is quite another matter whether it would be really useful.

One of the great advantages of the heated filament as a source of electrons is that it is controllable. You can regulate the filament temperature as you wish. When it is hot you get many electrons and a large tube current. When it is cool you get few electrons and small current. With a radium tube you could not do this. The number of electrons would be absolutely constant, almost exactly the same number, second by second, for hundreds of years. It seems to us, therefore, that the advantages of avoiding the heating battery and of long life, which advantages a radium tube would presumably offer, are more than offset by the disadvantage that the electron emission would not be controllable so easily and directly.

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Novel Innovations in Radio Detectors

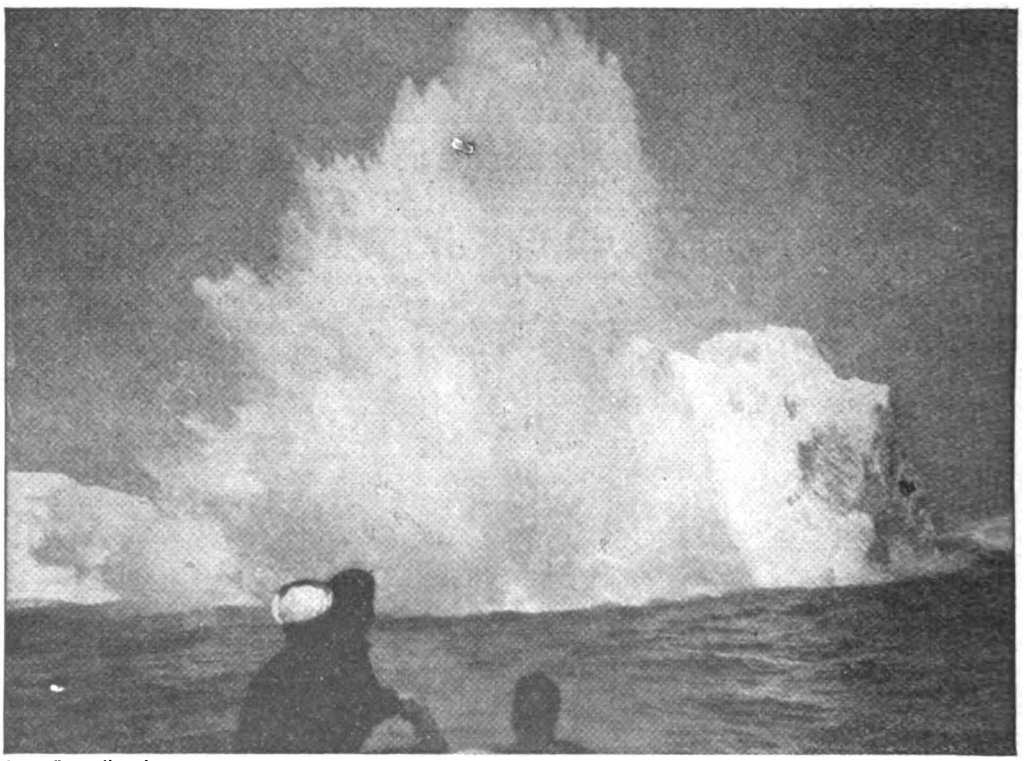
THREE years ago it was discovered that a charged metal plate placed in close contact with a non-conductor would adhere to it. The first experiments were with plates of metal pressed down tightly against the very smooth kind of stone used in lithography. The phenomenon was interpreted, no doubt correctly, as a special case of electrostatic attraction. Just as the negatively charged pith ball in the familiar high-school experiment approaches and adheres to the positively charged rod of glass or rubber, so the charged plate adheres to the stone, in which its charge has induced, of course, a charge of the opposite sign.

This effect was described by its discoverers, Dr. Alfred Johnsen and Dr. Knud Rahbek in the *Journal of the Institution of Electrical Engineers* (London) in 1921 and has since been well known to scientists under the name of the Johnsen-Rahbek effect.

According to a more recent article by these same scientists in the same *Journal* the effect has now been applied to the construction of several forms of telegraphic relay, one of which can operate as a radio recorder, and to a new form of loudspeaker. The principle is the same as in the earlier experiments but the apparatus is differently arranged. The plate of stone is replaced by a non-conducting cylinder (which may be of stone) revolving inside a metal strip. When this metal strip is charged it adheres a little to the revolving cylinder and the friction between them increases, just as though they were two pieces of ice between which you had poured a handful of ashes. This makes, of course, an increased drag on the metal strip, which drag may be recorded by the movement of a pen attached to the strip or in any other convenient fashion.

For the receipt of radio signals and for the loudspeaker the electric impulses are communicated to the metal strip. Whenever the potential of the strip is raised (by the signal) the strip adheres and drags. This sets the strip in vibration, the frequency being the same as that of the signal.

This application of electrostatics is interesting and well deserves attention but it does not seem to be quite as revolutionary as some of the published statements about it would



U. S. Coast Guard

RADIO GUARDS AGAINST THE ICEBERG PERIL

The chance of another great sea disaster like that of the ill-fated TITANIC *is now much lessened by radio. Special patrol boats watch for icebergs and ship captains who chance to sight them report to the Coast Guard by radio and a cutter is dispatched immediately to blow up the dangerous berg with T. N. T.*

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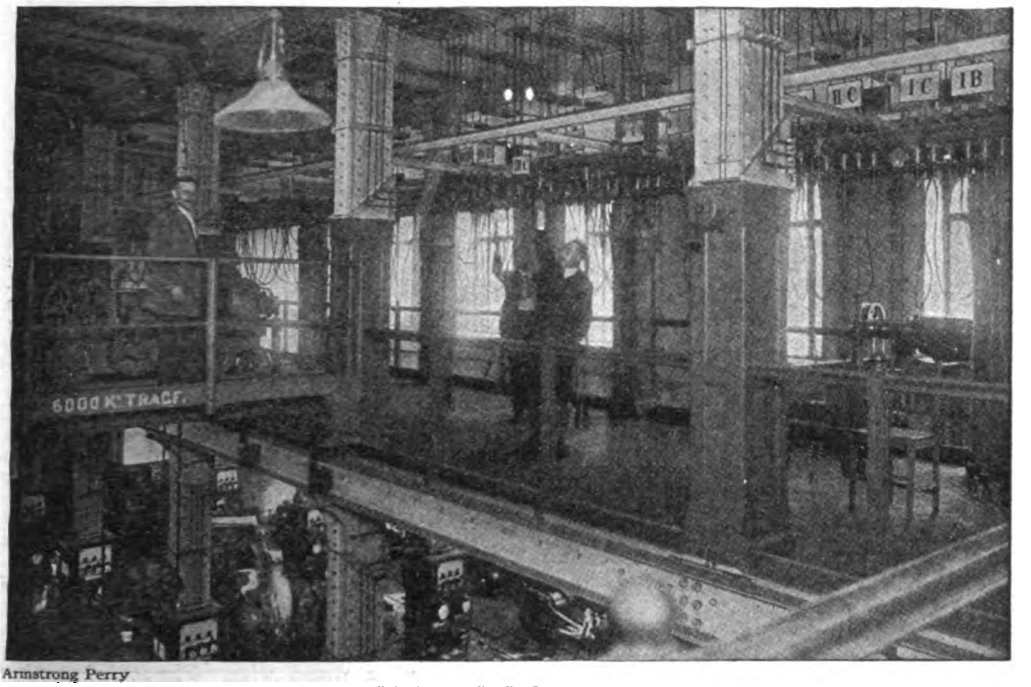

Armstrong Perry

A REMARKABLE ELECTRICAL LABORATORY IN AUSTRIA

The various experimental set-ups in the Electrotechnical Institute at Vienna are located on the floor beneath and the balcony is used for making "connections" to the apparatus below; the two men in the picture with their arms outstretched above their heads are pushing in the connecting plugs into the sockets located in the overhead switchboard. The laboratory is fully equipped with almost any kind of electric current from low-voltage D.C. to high-voltage D.C. and with alternating currents of all frequencies and voltages imaginable.

imply. In the loudspeaker, for example, it is difficult to see how this apparatus avoids trouble from the natural frequencies of the metal strip and of the attached apparatus, the same trouble that has caused so much difficulty with the forms of telephone and of loudspeaker that depend on vibrating diaphragms.

These objections do not apply, of course, to the use of the apparatus for the detection or recording of code signals, or for scientific uses or other purposes where it behaves merely as a sensitive relay. For example, a precision chronograph based on the Johnsen-Rahbek principle has been constructed in Germany[1] and it is announced that several other relay devices are in course of development.

There has been perfected in England a somewhat analogous form of detector which is now in use in several marine radio installations, including the Atlantic liner *Majestic*. This is the magnetic detector of Dr. N. W. McLachlan.[2] Instead of the revolving stone cylinder of the Johnsen-Rahbek apparatus, Dr. McLachlan employs a revolving drum of soft iron. Inside this drum are coils through which pass the feeble currents from the reception antenna or whatever other currents it is desired to magnify. Against the surface of the revolving iron drum, or rather in a little groove machined into the drum, there presses a small iron armature. Whenever a current passes through the coils inside the drum the magnetic attraction induced in the iron of the drum itself attracts the armature so that it drags on the drum surface, just as the metal strip drags on the stone cylinder used by Johnsen and Rahbek.

So far, the apparatus is merely one form of electromagnetic relay. The new principle comes in in the surprising fact, discovered by Dr. McLachlan, that the drag thus produced on the iron armature is over *fifty times greater* than it ought to be according to the customary theories of electromagnetic induction and of mechanical friction. It is evident that there is coming into play some unusual force, probably analogous to the forces discovered by Johnsen and Rahbek, and that this force, like the ashes on ice, increases materially the adherence between the revolving iron drum and the iron armature which touches against it.

1. "The Measurement of Bullet Velocities by an Electrical Apparatus Using the Johnsen-Rahbek Effect," by Karl Rottgardt. *Zeitschrift für technischen Physik*, Vol. 4, pages 63-65 (1923).

2. "The Application of a Revolving Magnetic Drum to Electric Relays, Siphon Recorders and Radio Transmitting Keys," by N. W. McLachlan. *Journal of the Inst. of Electrical Engineers (London)*, Vol. 61, pages 903-933 (August, 1923).

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Still another piece of recent apparatus makes use, though in a somewhat different fashion, of the friction between a moving surface and a fixed one. This is the new loudspeaker developed in England by Mr. S. G. Brown and christened by him the "frenophone." In this apparatus a glass disk, much like the disk-record of a phonograph, is made to revolve under a small vertical rod tipped, on its lower end, by a pad of flannel. An electromagnetic device of usual character is arranged to receive the current impulses from the detector and to translate them into mechanical pressures. Whenever a pulse of current is received the little flannel pad on the end of the vertical rod is pressed down a trifle more heavily against the glass disk revolving under it. This increases, of course, the drag of the flannel pad against the disk. If the current pulses have an audio frequency, as they do in speech reception, the flannel-tipped rod is set into vibration. This vibration is transmitted by a taut string to a diaphragm and a considerable volume of sound is thus produced.

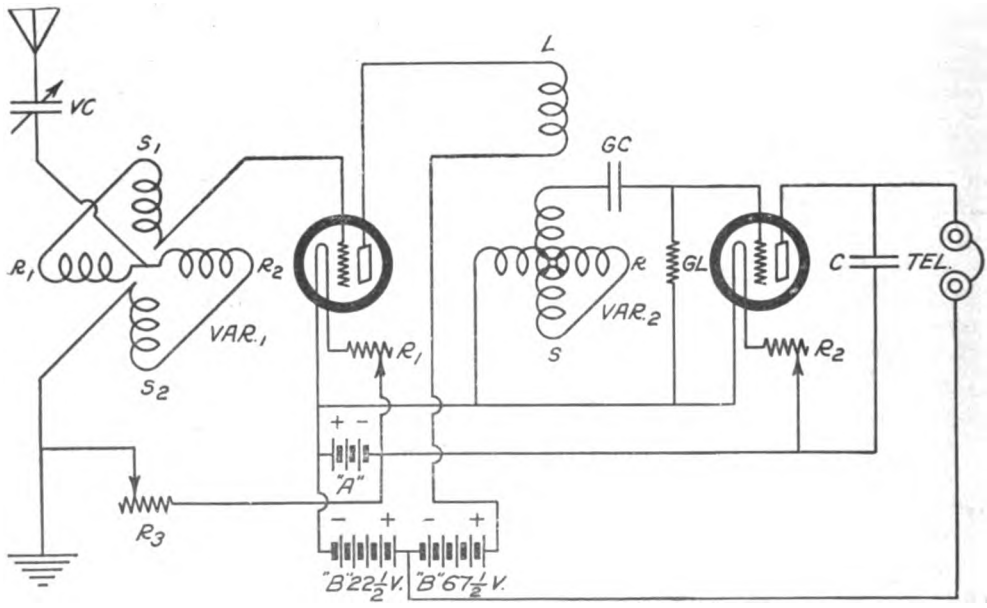
It is interesting to notice that all of these new devices accomplish really the same thing. They are mechanical amplifiers. A feeble disturbance created by the electric impulses is converted into a more ample disturbance, mechanically, not electrically. The extra power comes from the motor used to rotate the cylinder or the disk. Whether this plan of mechanical amplification will prove in the long run to be more efficient or less troublesome than electric amplification by vacuum tubes or electromagnetic amplification by transformers or relays, only time and further experiment will disclose.

How to Seal Wires Through Glass Tubes

THE most difficult problem that confronts the amateur maker of vacuum tubes for experimental purposes is that of sealing the necessary lead-in wires through the glass of the bulb. Even to a more or less experienced glass-blower this is a matter of some difficulty because the expansion and contraction of the wire with change of temperature is not the same as the percentage expansion of the glass. This difference in expansion produces strains that appear as soon as the glass-wire joint cools and that usually either break the glass or pull the wire loose from it.

Aid for the experimenter confronted with this problem is furnished by Mr. William G. Housekeeper, well-known experimenter with high-power tubes, who describes in a recent article the methods that he has developed for making this difficult glass-metal seal.[1] The secret is to make the contact of the glass and the metal as broad as possible. The strain is thus distributed over a larger surface and becomes less dangerous. Three definite methods have been developed. One is to flatten the wire so that it is somewhat ribbon-like. A second is to use an actual ribbon of metal instead of a round wire. The third method is the tube seal, a glass tube being sealed fast to a metal tube of approximately the same diameter.

1. "The Art of Sealing Base Metals Through Glass," by William G. Housekeeper, *Journal of the Amer. Inst. of Electrical Engineers*, Vol. 42, pages 954-960 (Sept., 1923).



A NEW RECEIVER FOR USE BELOW 100 METERS

This combination of tuned radio frequency with regeneration is used in the new short wave receiver devised by Mr. William F. Diehl and described by him recently in the radio section of the New York Sun and Globe.

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COAT the terminals of the storage battery with a thin covering of vaseline and you will prevent them from eating away.

* * *

Do not place the tuning coils (inductances, variocouplers, variometers) in your set so that they will be situated too near the wooden cabinet.

This will cause losses in the radio-frequency circuits if you do it. One set that was examined worked very poorly when the lid was shut down on it, but it worked well when the lid was left up. The tuning inductance was located so that it was extremely close to the varnished wood of the lid when it was down.

* * *

THE more sensitive a receiver is, the more selective it ought to be. This is true for two reasons. One is that the wider the distance range of the receiver, the more stations it will include. Some of these stations may be operating on wavelengths closely approximating each other. The other reason is that no transmitting station emits an absolutely sharp wave (a wave of but a single frequency). When a receiver is extremely sensitive some of the harmonics of nearby stations may force themselves into it unless it is highly selective at the same time.

* * *

ALWAYS ask for the best parts when you are buying apparatus for your new set. Pay a little more and get them from a reliable company. You will thus have better satisfaction when the set is completed and help to raise the standard of manufactured apparatus.

WHEN disconnecting batteries from a radio set, disconnect the wires at the batteries first. This will prevent short-circuits and will save the batteries. You will realize that if you disconnect the end of the wire attached to the set, first, it may twist or fly around and strike the opposite terminal of the battery before you get the other end disconnected. Always remember to do this and you will have on trouble with "shorts."

* * *

EVERY amateur with a transmitter should also have a good wavemeter.

* * *

SOMETIMES the connection tips of the vacuum tubes become corroded or dirty and the tube will not make proper connection in the vacuum-tube socket. This trouble is common and many fans never find out what the cause is.

Take a piece of fine emery cloth and shine up the lead on the tips till they are bright and then put the tube back in the socket and notice the difference in the strength of signals.

* * *

IF you have a tin or copper roof on your house, be sure that you place your antenna as high as possible above the roof; otherwise you will not have good results from either your transmitting or receiving apparatus.

* * *

NEVER try to charge your batteries while they are connected to your receiving set. You are liable to blow out the fuses in the lighting lines or burn out the tubes in your receiving set.

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THERE may be times when the family receiving set will be the center of rather heated argument. One of the family may wish to listen to WJZ to the athletic or sporting events and another of the family may insist on listening to famous cooking recipes broadcast from WEAF. Or, one may insist on "opera" while another member wants "jazz."

In a dispute over possession of the headphones, there may be quite serious damage done to the phones, the set, or the family.

Here is one way to overcome the difficulty. Build a simple duplex receiver with three honeycomb coils that will allow of reception, with headphones, of two different programs *at the same time!*

The circuit is shown in Figure 1. The parts necessary for the construction of such a set are the following:

L1, L2, and L3—honeycomb coils, size L-50, L-35, and L-50 respectively;

VC1 and VC2—variable condenser, .0005 mfd.;

GL1 and GL2—grid leaks, 2 megohms;

GC1 and GC2—grid condensers, .00025 mfd.;

VAR 1 and VAR 2—variometers;

C1 and C2—mica fixed condensers, .0005 mfd.;

R1 and R2—filament rheostats;

TEL 1 and TEL 2—two pairs of headsets;

Suitable tubes, and "A" and "B" batteries.

The three coils may be set in a triple-coil mounting and the two sets mounted in the same cabinet, with one set at the right with the tuning controls marked "For the ladies," and the other set at the left with the tuning controls marked "For the men."

The two sets may be used simultaneously without interference if the circuits are not allowed to oscillate. They will tune in two different programs with good signal strength.

In this way the set may furnish double service.

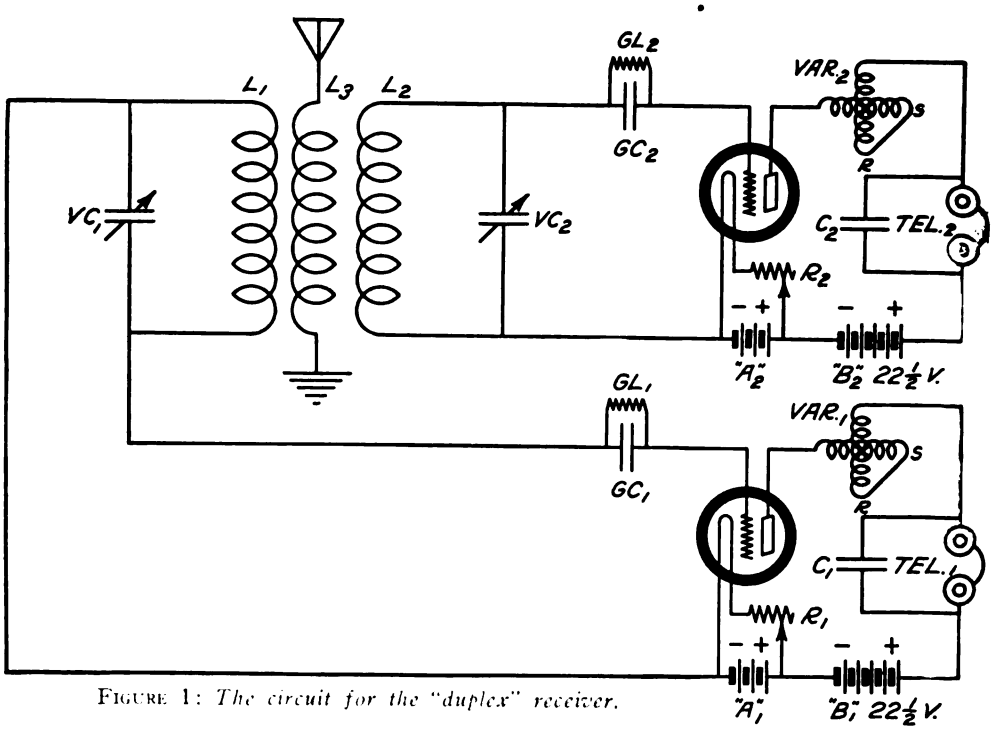

FIGURE 1: *The circuit for the "duplex" receiver.*

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HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

The Broadcasting Stations of the United States

HERE is a complete list of all of the broadcasting stations in this country, corrected up to November 16, 1923. Readers may keep this list up to date without much trouble by noting the slight occasional changes that are recorded in the daily newspapers throughout the country.

Call Letters	*Location of station*	*Power (watts)*	*Wave-length (meters)*	*Freq. (kilo-cycles)*
KDKA	East Pittsburgh, Pa.	1,000	326	920
KDPM	Cleveland, Ohio	250	270	1,110
KDPT	San Diego, Cal.	50	249	1,230
KDYL	Salt Lake City, Utah	50	360	833
KDYM	San Diego, Cal.	50	252	1,190
KDYQ	Portland, Ore.	5	360	833
KDYS	Great Falls, Mont.	50	360	833
KDYW	Phoeniz, Ariz.	20	360	833
KDYX	Honolulu, Hawaii	100	360	833
KDZB	Bakersfield, Cal.	100	240	1,250
KDZE	Seattle, Wash.	100	455	660
KDZF	Los Angeles, Cal.	500	278	1,080
KDZI	Wenatchee, Wash.	50	360	833
KDZK	Reno, Nev.	25	360	833
KDZQ	Denver, Col.	10	360	833
KDZR	Bellingham, Wash.	50	261	1,150
KDZT	Seattle, Wash.	10	360	833
KFAD	Phoenix, Ariz.	100	360	833
KFAE	Pullman, Wash.	500	360	833
KFAF	Denver, Col.	500	360	833
KFAJ	Boulder, Col.	100	360	833
KFAN	Moscow, Idaho	50	360	833
KFAP	Butte, Mont.	100	360	833
KFAR	Hollywood, Cal.	200	280	1,070
KFAU	Boise, Idaho	150	270	1,110
KFAV	Venice, Cal.	5	224	1,340
KFAW	Santa Ana, Cal.	10	280	1,070
KFAY	Medford, Ore.	50	283	1,060
KFBB	Havre, Mont.	50	360	833
KFBC	San Diego, Cal.	20	278	1,080
KFBE	San Luis Obispo, Cal.	10	360	833
KFBG	Tacoma, Wash.	50	360	833
KFBK	Sacramento, Cal.	100	283	1,060
KFBL	Everett, Wash.	10	224	1,340
KFBS	Trinidad, Col.	15	360	833
KFBU	Laramie, Wyo.	50	283	1,060
KFCB	Phoenix, Ariz.	10	238	1,260
KFCD	Salem, Ore.	20	360	833
KFCF	Walla Walla, Wash.	50	360	833
KFCH	Billings, Mont.	10	360	833
KFCK	Colorado Springs, Col.	10	258	1,160
KFCL	San Antonio, Cal.	500	360	833
KFCM	Richmond, Cal.	100	360	833
KFCP	Ogden, Utah	25	360	833
KFCV	Houston, Tex.	10	360	833
KFCY	Le Mars, Iowa	50	252	1,190
KFCZ	Omaha, Neb.	100	258	1,160
KFDA	Baker, Ore.	5	360	833
KFDD	Boise, Idaho	10	252	1,190
KFDH	Tucson, Ariz.	150	360	833
KFDJ	Corvallis, Ore.	50	360	833
KFDL	Denver, Col.	5	360	833
KFDO	Bozeman, Mont.	50	248	1,210
KFDR	York, Neb.	10	360	833
KFDU	Lincoln, Neb.	20	240	1,250
KFDV	Fayetteville, Ark.	200	360	833
KFDX	Shreveport, La.	100	360	833
KFDY	Brookings, S. Dak.	100	360	833
KFDZ	Minneapolis, Minn.	5	360	833
KFEC	Portland, Ore.	50	360	833
KFEJ	Tacoma, Wash.	10	360	833
KFEL	Denver, Col.	50	360	833
KFEP	Denver, Col.	10	240	1,250
KFEQ	Oak, Neb.	150	360	833
KFER	Port Dodge, Iowa	20	231	1,300
KFEV	Douglas, Wyo.	100	263	1,140
KFEX	Minneapolis, Minn.	100	261	1,150
KFEY	Kellogg, Idaho	10	360	833
KFEZ	St. Louis, Mo.	100	360	833
KFFA	San Diego, Cal.	50	242	1,240
KFFB	Boise, Idaho	10	240	1,250
KFFE	Pendelton, Ore.	10	360	833
KFFO	Hillsboro, Ore.	5	229	1,310
KFFQ	Colorado Springs, Col.	100	360	833
KFFR	Sparks, Nev.	10	226	1,330
KFFV	Lamoni, Iowa	100	360	833
KFFX	Omaha, Neb.	250	278	1,080
KFFY	Alexandria, La.	100	275	1,090
KFFZ	Dallas, Tex. (portable)	20	226	1,330
KFGC	Baton Rouge, La.	100	254	1,180
KFGD	Chickasha, Okla.	20	248	1,210
KFGH	Stanford University, Cal.	500	360	833
KFGJ	St. Louis, Mo.	250	266	1,130
KFGL	Arlington, Ore.	5	234	1,280
KFGQ	Boone, Iowa	10	226	1,330
KFGV	Utica, Neb.	10	224	1,340
KFGX	Orange, Tex.	500	250	1,200
KFGZ	Berrien Springs, Mich.	10	268	1,120
KFHA	Gunnison, Col.	50	252	1,190
KFHB	Hood River, Ore.	5	280	1,070
KFHD	St. Joseph, Mo.	100	226	1,330
KFHP	Shreveport, La.	150	266	1,130
KFHH	Neah Bay, Wash.	50	283	1,060
KFHJ	Santa Barbara, Cal.	100	360	833
KFHQ	Los Gatos, Cal.	5	242	1,240
KFHR	Seattle, Wash.	100	270	1,110
KFHS	Lihue, Hawaii	30	275	1,090
KFHU	Mayville, N. Dak.	50	261	1,150
KFHX	Hutchinson, Kans.	50	229	1,310
KFI	Los Angeles, Cal.	500	469	640

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Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)
KFIB	St. Louis, Mo.	10	244	1,230
KFID	Iola, Kan.	20	246	1,220
KFIF	Portland, Ore.	100	360	833
KFIK	Gladbrook, Iowa	20	234	1,280
KFIL	Louisburg, Kan.	30	234	1,280
KFIO	Spokane, Wash.	50	252	1,190
KFIQ	Yakima, Wash.	50	224	1,340
KFIU	Juneau, Alaska	10	226	1,330
KFIV	Pittsburg, Kan.	20	240	1,250
KFIX	Independence, Mo.	250	240	1,250
KFIY	Seattle, Wash.	15	236	1,270
KFIZ	Pond du Lac, Wis.	100	273	1,100
KFJA	Grand Island, Neb.	100	244	1,230
KFJB	Marshalltown, Iowa	10	248	1,210
KFJC	Seattle, Wash.	100	233	1,290
KFJD	Greeley, Col.	50	236	1,270
KFJF	Oklahoma City, Okla.	20	252	1,190
KFJH	Selma, Cal.	10	273	1,100
KFJI	Astoria, Ore.	10	252	1,190
KFJJ	Carrollton, Mo.	50	236	1,270
KFJK	Bristow, Okla.	100	233	1,290
KFJL	Ottumwa, Iowa	10	242	1,240
KFJM	Grand Forks, N. D.	100	229	1,310
KFJR	Stevensville, Mont.	50	258	1,160
KFJU	Kearney, Neb.	10	234	1,280
KFJV	Dexter, Iowa	10	224	1,340
KFJW	Towanda, Kan.	10	226	1,330
KFJX	Cedar Falls, Iowa	50	229	1,310
KFJY	Fort Dodge, Iowa	50	246	1,220
KFJZ	Fort Worth, Tex.	20	254	1,180
KFKA	Greeley, Col.	50	248	1,210
KFKB	Milford, Kan.	500	286	1,050
KFKH	Lakeside, Col.	10	226	1,330
KFKX	Hastings, Neb.	500	286	1,050
KFLE	Denver, Col.	25	268	1,120
KFLQ	Little Rock, Ark.	20	261	1,150
KFLR	Albuquerque, N. M.	100	254	1,180
KGB	Tacoma, Wash.	50	252	1,190
KGG	Portland, Ore.	50	360	833
KGN	Portland, Ore.	100	360	833
KGU	Honolulu, Hawaii, Waikiki Beach	250	360	833
KGW	Portland, Ore.	500	492	610
KGY	Lacy, Wash.	5	258	1,160
KHJ	Los Angeles, Cal.	500	395	760
KHQ	Seattle, Wash.	100	360	833
KJQ	Stockton, Cal.	5	360	833
KJR	Seattle, Wash.	100	270	1,110
KJS	Los Angeles, Cal.	750	360	833
KLN	Monterey, Cal.	10	261	1,150
KLS	Oakland, Cal.	250	360	833
KLX	Oakland, Cal.	250	360	833
KLZ	Denver, Col.	500	360	833
KMJ	Fresno, Cal.	250	273	1,100
KMO	Tacoma, Wash.	10	360	833
KNJ	Roswell, N. Mex.	500	250	1,200
KNT	Aberdeen, Wash.	250	263	1,140
KNV	Los Angeles, Cal.	100	256	1,179
KNX	Los Angeles, Cal.	100	360	833
KOB	State College, N. Mex.	500	360	833
KOP	Detroit, Mich.	500	286	1,050
KPO	San Francisco, Cal.	500	423	710
KQI	Berkeley, Cal.	500	360	833
KQP	Hood River, Ore.	10	360	833
KQV	Pittsburgh, Pa.	500	360	833
KQW	San Jose, Cal.	50	360	833
KRE	Berkeley, Cal.	50	278	1,080
KSD	St. Louis, Mo.	500	546	550
KSS	Long Beach, Cal.	20	360	833
KTW	Seattle, Wash.	500	360	833
KUO	San Francisco, Cal.	150	360	833
KUS	Los Angeles, Cal.	100	360	833
KUY	El Monte, Cal.	50	256	1,170
KWG	Stockton, Cal.	100	360	833
KWH	Los Angeles, Cal.	500	360	833
KXD	Modesto, Cal.	10	252	1,190
KYQ	Honolulu, Hawaii	20	360	833
KYW	Chicago, Ill.	1,000	536	560
KZM	Oakland, Cal.	50	360	833
KZN	Salt Lake City, Utah	500	360	833
KZV	Wenatchee, Wash.	50	360	833
WAAB	New Orleans, La.	100	268	1,120
WAAC	New Orleans, La.	400	360	833
WAAD	Cincinnati, Ohio	25	360	833
WAAF	Chicago, Ill.	200	286	1,050
WAAK	Milwaukee, Wis.	100	280	1,070
WAAM	Newark, N. J.	250	263	1,140
WAAN	Columbia, Mo.	50	254	1,180
WAAW	Omaha, Neb.	200	360	833
WAAZ	Emporia, Kan.	100	360	833
WABB	Harrisburg, Pa.	10	266	1,130
WABC	Anderson, Ind.	10	229	1,310
WABD	Dayton, Ohio	10	283	1,060
WABE	Washington, D. C.	50	283	1,060
WABF	Mount Vernon, Ill.	100	234	1,280
WABG	Jacksonville, Fla.	10	248	1,210
WABH	Sandusky, Ohio	20	240	1,250
WABI	Bangor, Me.	50	240	1,250
WABJ	South Bend, Ind.	10	240	1,250
WABK	Worcester, Mass.	10	252	1,190
WABL	Storrs, Conn.	100	283	1,060
WABM	Saginaw, Mich.	100	254	1,180
WABN	La Crosse, Wis.	250	244	1,230
WABO	Rochester, N. Y.	10	252	1,190
WABP	Dover, Ohio	100	266	1,130
WBAA	West Lafayette, Ind.	250	360	833
WBAD	Minneapolis, Minn.	100	360	833
WWAE	Joliet, Ill.	500	227	1,320
WBAH	Minneapolis, Minn	500	417	720
WBAN	Paterson, N. J.	100	244	1,230
WBAO	Decatur, Ill.	50	360	833
WBAP	Fort Worth, Tex.	750	476	630
WBAV	Columbus, Ohio.	500	390	770
WBAW	Marietta, Ohio.	250	246	1,220
WBAX	Wilkes-Barre, Pa.	20	360	833
WBAY	New York, N. Y.	500	492	610
WBBA	Newark, Ohio.	20	240	1,250
WBBD	Reading, Pa.	50	234	1,280
WBL	Anthony, Kan.	100	261	1,150
WBS	Newark, N. J.	20	360	833
WBT	Charlotte, N. C.	500	360	833
WBZ	Springfield, Mass.	750	337	890
WCAD	Canton, N. Y.	250	280	1,070
WCAE	Pittsburgh, Pa.	500	462	650
WCAG	New Orleans, La.	50	268	1,120
WCAH	Columbus, Ohio.	100	286	1,050
WCAJ	University Place, Neb.	500	360	833
WCAK	Houston, Tex.	50	360	833
WCAL	Northfield, Minn.	250	360	833
WCAM	Villanova, Pa.	150	360	833
WCAO	Baltimore, Md.	50	360	833
WCAP	Washington, D. C.	500	469	640
WCAR	San Antonio, Tex.	150	360	833
WCAS	Minneapolis, Minn.	100	246	1,220
WCAT	Rapid City, S. D.	50	240	1,250
WCAU	Philadelphia, Pa.	250	286	1,050
WCAV	Little Rock, Ark.	20	360	833
WCAX	Burlington, Vt.	50	360	833
WCAY	Milwaukee, Wis.	250	261	1,150
WCAZ	Carthage, Ill.	50	246	1,220
WCBA	Allentown, Pa.	5	280	1,070
WCBB	Greenville, Ohio.	100	240	1,250
WCBD	Zion, Ill.	500	345	870
WCE	Minneapolis, Minn.	250	360	833
WCK	St. Louis, Mo.	100	360	833
WCM	Austin, Tex.	500	360	833
WCX	Detroit, Mich.	500	517	580
WDAE	Tampa, Fla.	250	360	833
WDAF	Kansas City, Mo.	500	411	730
WDAG	Amarillo, Tex.	100	263	1,140
WDAH	El Paso, Tex.	100	286	1,120
WDAI	Syracuse, N. Y.	100	246	1,220
WDAK	Hartford, Conn.	100	261	1,150
WDAL	Jacksonville, Fla.	100	360	833
WDAO	Dallas, Tex.	50	360	833
WDAP	Chicago, Ill.	500	360	833
WDAR	Philadelphia, Pa.	500	395	760
WDAS	Worcester, Mass.	5	360	833
WDAU	New Bedford, Mass.	100	360	833
WDAX	Centerville, Iowa.	100	360	833
WDAY	Fargo, N. D.	50	244	1,230
WDBC	Lancaster, Pa.	50	258	1,160
WDBF	Youngstown, Ohio.	50	261	1,150
WDM	Washington, D. C.	50	360	833
WDT	New York, N. Y.	500	405	740
WDZ	Tuscola, Ill.	10	278	1,080
WEAA	Flint, Mich.	150	280	1,070
WEAF	New York, N. Y.	500	492	610
WEAH	Wichita, Kan.	50	244	1,230
WEAI	Ithaca, N. Y.	500	286	1,050
WEAJ	Vermillon, S. D.	200	283	1,060
WEAM	North Plainfield, N. J.	100	252	1,190
WEAN	Providence, R. I.	100	273	1,100
WEAO	Columbus, Ohio.	500	360	833
WEAP	Mobile, Ala.	100	360	833
WEAR	Baltimore, Md.	50	360	833
WEAS	Washington, D. C.	50	360	833
WEAU	Sioux City, Iowa	100	360	833
WEAY	Houston, Tex.	250	360	833
WEB	St. Louis, Mo.	500	360	833
WEV	Houston, Tex.	50	360	833
WEW	St. Louis, Mo.	100	261	1,150

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Call Letters	Location of station.	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)
WPAA	Dallas, Tex.	500	476	630
WPAB	Syracuse, N. Y.	200	234	1,280
WPAP	Poughkeepsie, N. Y.	20	360	833
WPAH	Port Arthur, Tex.	150	236	1,270
WPAJ	Asheville, N. C.	50	360	833
WPAM	St. Cloud, Minn.	20	360	833
WPAN	Hutchinson, Minn.	100	360	833
WPAQ	Cameron, Mo.	10	360	833
WPAT	Sioux Falls, S. D.	100	360	833
WPAV	Lincoln, Neb.	500	275	1,090
WPI	Philadelphia, Pa.	500	395	760
WGAL	Lancaster, Pa.	10	248	1,210
WGAN	Pensacola, Fla.	50	360	833
WGAQ	Shreveport, La.	100	360	833
WGAR	Fort Smith, Ark.	20	360	833
WGAU	Wooster, Ohio	20	226	1,330
WGAW	Altoona, Pa.	100	261	1,150
WGAY	Madison, Wis.	100	360	833
WGAZ	South Bend, Ind.	50	360	833
WGI	Medford Hillside, Mass.	500	360	833
WGL	Philadelphia, Pa.	500	360	833
WGR	Buffalo, N. Y.	500	319	940
WGV	New Orleans, La.	100	360	833
WGY	Schenectady, N. Y.	1,000	380	790
WHA	Madison, Wis.	500	360	833
WHAA	Iowa City, Iowa	100	283	1,060
WHAB	Galveston, Tex.	200	360	833
WHAC	Waterloo, Iowa	10	360	833
WHAD	Milwaukee, Wis.	100	280	1,070
WHAG	Cincinnati, Ohio	200	222	1,350
WHAH	Joplin, Mo.	250	360	833
WHAI	Davenport, Iowa	50	360	833
WHAK	Clarksburg, W. Va.	15	258	1,160
WHAL	Lansing, Mich.	20	248	1,210
WHAM	Rochester, N. Y.	100	360	833
WHAP	Decatur, Ill.	50	360	833
WHAQ	Washington, D. C.	10	360	833
WHAR	Atlantic City, N. J.	10	231	1,300
WHAS	Louisville, Ky.	500	400	750
WHAV	Wilmington, Del.	50	360	833
WHAZ	Troy, N. Y.	500	380	790
WHB	Kansas City, Mo.	500	411	730
WHD	Morgantown, W. Va.	250	360	833
WHK	Cleveland, Ohio	500	360	833
WHN	New York, N. Y.	100	360	833
WIAB	Rockford, Ill.	50	252	190
WIAC	Galveston, Tex.	100	360	833
WIAD	Ocean City, N. J.	10	254	1,180
WIAP	New Orleans, La.	10	234	1,280
WIAH	Newton, Iowa	10	258	1,160
WIAI	Springfield, Mo.	20	252	1,190
WIAJ	Neenah, Wis.	100	224	1,340
WIAK	Omaha, Neb.	200	278	1,080
WIAO	Milwaukee, Wis.	100	360	833
WIAQ	Marion, Ind.	10	226	1,330
WIAR	Paducah, Ky.	100	360	833
WIAS	Burlington, Iowa	100	360	833
WIAT	Tarkio, Mo.	15	360	833
WIAU	Le Mars, Iowa	20	360	833
WIK	McKeesport, Pa.	500	234	1,280
WIL	Washington, D. C.	10	360	833
WIP	Philadelphia, Pa.	500	509	590
WJAB	Lincoln, Neb.	500	360	833
WJAD	Waco, Tex.	150	360	833
WJAF	Muncie, Ind.	10	360	833
WJAG	Norfolk, Neb.	200	360	833
WJAK	Greentown, Ind.	30	254	1,180
WJAM	Cedar Rapids, Iowa	20	268	1,120
WJAN	Peoria, Ill.	100	280	1,070
WJAQ	Topeka, Kan.	100	360	833
WJAR	Providence, R. I.	50	360	833
WJAS	Pittsburgh, Pa.	500	360	833
WJAT	Marshall, Mo.	10	360	833
WJAX	Cleveland, Ohio	500	390	770
WJAZ	Chicago, Ill.	1,000	448	670
WJD	Granville, Ohio	50	229	1,310
WJH	Washington, D. C.	50	273	1,100
WJX	New York, N. Y.	500	360	833
WJY	New York, N. Y.	500	405	740
WJZ	New York, N. Y.	500	455	660
WKAA	Cedar Rapids, Iowa	100	268	1,120
WKAD	East Providence, R. I.	10	240	1,250
WKAP	Wichita Falls, Tex.	100	360	833
WKAN	Montgomery, Ala.	15	226	1,330
WKAP	Cranston, R. I.	200	360	833
WKAQ	San Juan, P. R.	100	360	833
WKAR	East Lansing, Mich.	250	280	1,070
WKAS	Springfield, Mo.	10	360	833
WKAV	Laconia, N. H.	50	254	1,180
WKAW	Beloit, Wis.	10	242	1,240
WKAY	Gainesville, Ga.	10	280	1,070
WKC	Baltimore, Md.	20	360	833
WKY	Oklahoma, Okla.	100	360	833
WLAG	Minneapolis, Minn.	500	417	720
WLAH	Syracuse, N. Y.	250	234	1,280
WLAJ	Waco, Tex.	150	360	833
WLAK	Bellows Falls, Vt.	500	360	833
WLAL	Tulsa, Okla.	100	360	833
WLAN	Houlton, Me.	250	283	1,060
WLAP	Louisville, Ky.	15	360	833
WLAQ	Kalamazoo, Mich.	20	360	833
WLAT	Burlington, Iowa	10	360	833
WLAV	Pensacola, Fla.	15	254	1,180
WLAW	New York, N. Y.	500	360	833
WLAX	Greencastle, Ind.	10	231	1,300
WLB	Minneapolis, Minn.	100	360	833
WLW	Cincinnati, Ohio	500	309	970
WMAB	Oklahoma, Okla.	100	360	833
WMAC	Cazenovia, N. Y.	200	261	1,150
WMAF	Dartmouth, Mass.	100-500	360	833
WMAH	Lincoln, Neb.	100	254	1,180
WMAJ	Kansas City, Mo.	250	275	1,090
WMAK	Lockport, N. Y.	500	360	833
WMAL	Trenton, N. J.	50	256	1,170
WMAN	Columbus, Ohio.	10	286	1,050
WMAP	Easton, Pa.	50	246	1,220
WMAQ	Chicago, Ill.	250	448	670
WMAV	Auburn, Ala.	500	250	1,200
WMAY	St. Louis, Mo.	100	280	1,070
WMAZ	Macon, Ga.	50	268	1,120
WMC	Memphis, Tenn.	500	500	600
WMH	Cincinnati, Ohio	10	248	1,210
WMU	Washington, D. C.	100	261	1,150
WNAC	Boston, Mass.	100	278	1,080
WNAD	Norman, Okla.	100	360	833
WNAL	Omaha, Neb.	20	242	1,240
WNAM	Evansville, Ind.	500	360	833
WNAN	Syracuse, N. Y.	100	286	1,050
WNAP	Springfield, Ohio	100	231	1,300
WNAQ	Charleston, S. C.	10	360	833
WNAR	Butler, Mo.	20	231	1,300
WNAS	Austin, Tex.	100	360	833
WNAT	Philadelphia, Pa.	100	360	833
WNAV	Knoxville, Tenn.	500	236	1,270
WNAW	Port Monroe, Va.	5	360	833
WNAX	Yankton, S. D.	100	244	1,230
WNJ	Albany, N. Y.	55	360	833
WOAA	Ardmore, Okla.	100	360	833
WOAC	Lima, Ohio	50	266	1,130
WOAD	Sigourney, Iowa	10	360	833
WOAE	Fremont, Neb.	20	360	833
WOAF	Tyler, Tex.	10	360	833
WOAG	Belvidere, Ill.	100	224	1,340
WOAH	Charleston, S. C.	100	360	833
WOAI	San Antonio, Tex.	500	385	780
WOAJ	Parsons, Kan.	15	258	1,160
WOAL	Webster Groves, Mo.	500	229	1,310
WOAN	Lawrenceburg, Tenn.	150	360	833
WOAO	Mishawaka, Ind.	50	360	833
WOAP	Kalamazoo, Mich.	50	240	1,250
WOAQ	Portsmouth, Va.	15	360	833
WOAT	Wilmington, Del.	50	360	833
WOAV	Erie, Pa.	100	242	1,240
WOAW	Omaha, Neb.	500	526	570
WOAX	Trenton, N. J.	100	240	1,250
WOAZ	Stamford, Tex.	100	360	833
WOC	Davenport, Iowa	500	484	620
WOI	Ames, Iowa	100	360	833
WOK	Pine Bluff, Ark.	500	360	833
WOO	Philadelphia, Pa.	500	509	590
WOQ	Kansas City, Mo.	500	360	833
WOR	Newark, N. J.	500	405	740
WOS	Jefferson City, Mo.	500	441	680
WPAB	State College, Pa.	500	360	833
WPAC	Okmulgee, Okla.	200	360	833
WPAD	Chicago, Ill.	500	360	833
WPAH	Waupaca, Wis.	250	360	833
WPAJ	New Haven, Conn.	10	268	1,120
WPAK	Agricultural College, N. D.	250	360	833
WPAL	Columbus, Ohio.	100	286	1,050
WPAM	Topeka, Kan.	100	360	833
WPAP	Winchester, Ky.	35	360	833
WPAQ	Frostburg, Md.	10	360	833
WPAR	Beloit, Kan.	10	360	833
WPAT	El Paso, Tex.	20	360	833
WPAU	Moorehead, Minn.	20	360	833
WPAZ	Charleston, W. Va.	20	273	1,100
WPG	New Lebanon, Ohio	50	234	1,280
WQAA	Parkersburg, Pa.	500	360	833
WQAC	Amarillo, Tex.	100	360	833
WQAD	Waterbury, Conn.	50	242	1,240
WQAE	Springfield, Vt.	50	275	1,090

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Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)
WQAF	Sandusky, Ohio	5	240	1,250
WQAH	Lexington, Ky	10	254	1,180
WQAL	Mattoon, Ill	10	258	1,160
WQAM	Miami, Fla	100	360	833
WQAN	Scranton, Pa	100	280	1,070
WQAO	New York, N. Y	100	360	833
WQAQ	Abilene, Tex	100	360	833
WQAS	Lowell, Mass	100	266	1,130
WQAV	Greenville, S. C	15	258	1,160
WQAW	Washington, D. C	5	236	1,270
WQAX	Peoria, Ill	10	360	833
WRAA	Houston, Tex	200	360	833
WRAD	Marion, Kan	10	248	1,210
WRAF	Laporte, Ind	10	224	1,340
WRAH	Providence, R. I	10	231	1,300
WRAL	St. Croix, Falls, Wis	100	248	1,210
WRAM	Galesburg, Ill	250	244	1,230
WRAN	Waterloo, Iowa	10	236	1,270
WRAO	St. Louis, Mo	100	360	833
WRAU	Amarillo, Tex	10	360	833
WRAV	Yellow Springs, Ohio	100	360	833
WRAW	Reading, Pa	10	238	1,260
WRAX	Gloucester City, N. J	100	268	1,120
WRAY	Scranton, Pa	100	280	1,070
WRAZ	Newark, N. J	50	233	1,290
WRC	Washington, D. C	500	469	640
WRK	Hamilton, Ohio	200	360	833
WRL	Schenectady, N. Y	500	360	833
WRM	Urbana, Ill	500	360	833
WRR	Dallas, Tex	20	360	833
WRW	Tarrytown, N. Y	150	273	1,100
WSAB	Cape Girardeau, Mo	100	360	833
WSAC	Clemson College, S. C	500	360	833
WSAD	Providence, R. I	100	261	1,150
WSAG	St. Petersburg, Fla	10	244	1,230
WSAH	Chicago, Ill	500	248	1,210
WSAI	Cincinnati, Ohio	500	309	970
WSAJ	Grove City, Pa	100	360	833
WSAK	Middleport, Ohio	70	258	1,160
WSAL	Brookville, Ind	10	246	1,220
WSAN	Allentown, Pa	10	229	1,310
WSAP	New York, N. Y	250	360	833
WSAR	Fall River, Mass	10	254	1,180
WSAT	Plainview, Tex	20	268	1,120
WSAW	Canandaigua, N. Y	100	275	1,090
WSAX	Chicago, Ill	20	268	1,120
WSB	Atlanta, Ga	500	429	700
WSL	Utica, N. Y	100	273	1,100
WSY	Birmingham, Ala	500	360	833
WTAB	Fall River, Mass	10	248	1,210
WTAC	Johnstown, Pa	150	360	833
WTAD	Carthage, Ill	10	229	1,310
WTAF	New Orleans, La	20	242	1,240
WTAG	Providence, R. I	10	258	1,160
WTAH	Belvidere, Ill	10	236	1,270
WTAJ	Portland, Me	50	236	1,270
WTAL	Toledo, Ohio	10	252	1,190
WTAM	Cleveland, Ohio	1,000	390	770
WTAN	Mattoon, Ill	100	240	1,250
WTAP	Cambridge, Ill	50	242	1,240
WTAQ	Osseo, Wis	100	226	1,330
WTAR	Norfolk, Va	100	280	1,070
WTAS	Elgin, Ill (portable)	500	275	1,090
WTAT	Boston, Mass	100	244	1,230
WTAU	Tecumseh, Neb	10	360	833
WTAW	College Station, Tex	50	280	1,070
WTG	Manhattan, Kan	1,000	360	833
WWAB	Trenton, N. J	10	226	1,330
WWAC	Waco, Tex	50	360	833
WWAD	Philadelphia, Pa	50	360	833
WWAX	Laredo, Tex	50	360	833
WWB	Canton, Ohio	100	268	1,120
WWI	Dearborn, Mich	50	273	1,100
WWJ	Detroit, Mich	500	517	580
WWL	New Orleans, La	100	280	1,070

A LIST of the more important broadcasting stations abroad—stations that the American radio fans are most likely to pick up during this winter—was published in POPULAR RADIO for December, together with information concerning their usual program hours, location, wavelength and the general nature of their broadcast material.

Kadel & Herbert

How to Build a Three-tube Reflex Receiver

Two stages of radio-frequency amplification, a vacuum-tube detector, and two stages of audio-frequency amplification—and with only three tubes! A set that embodies these features of high amplification and tube economy will be described by Walter Remy in the February issue of POPULAR RADIO *out January 20th. This set, by the way, won first prize at a recent amateur convention and radio show in New York.*

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What is the latest information about the very long radio waves supposed to be coming from Mars?

There has not been any very important work on these waves lately. The distinguished English scientist, Dr. Fournier d'Albe stated recently that these long-wave signals had been found, in Europe, to arrive simultaneously at all stations observing them. This apparently indicates that they are real and suggests, at least, an origin outside the earth. The prevailing opinion among scientific men seems to be that these waves originate in some sort of electrical disturbance in the sun. There is no reason at all to suspect that they represent attempts of inhabitants of Mars to communicate with us. The whole matter needs further study. Any amateur who has means and opportunity to construct receiving apparatus for these long waves (50,000 to 150,000 meters) could render great service to science by keeping exact records over a period of months of their times and strengths.

Why does not a magnetic compass point exactly to the north?

It points toward the earth's *magnetic* pole and this is not quite coincident with the real North Pole, which is the end of the axis about which the earth revolves. The magnetism of the earth is supposed to be due mainly to currents of electricity that circulate inside the earth, like the current in the wire around an electromagnet. Apparently these currents do not revolve around exactly the same axis as does the earth itself, so the magnetic forces are displaced sidewise a little. The currents are variable, too, so the position of the magnetic pole moves slowly, causing the actual direction of the compass to change a little each year.

Why does an electric spark produce light?

The light is *not* due directly to the electricity, as many people think. It is produced, really, by heat, just as the light is in a fire. An electric spark is caused by a great number of electrons (which are, you remember, little particles of electricity) jumping across through the air from one wire to another. As this great crowd of electrons, billions of billions of them, jump through the air, they knock the atoms of the air itself about so much that these atoms get very hot—so hot that they give out light. There are also some atoms of copper or other material detached from the wires and carried along by the spark. These get hot and shine, too. That is why a spark from a copper wire looks greenish. The atoms of copper, when they get hot enough, shine with a greenish light instead of a white light.

What is the smallest electric current that can be measured?

The amount of electricity in one electron has been measured by Millikan, but this is a measurement, really, of electric *charge*, rather than of current. The smallest actual current measured so far is probably that detected last summer by Dr. C. G. Abbott of the Smithsonian Institution while he was engaged in determining, by means of a thermopile, the amount of heat received from an individual star. The current measured was about one-trillionth of an ampere. A current as small as this would have to flow for over 60,000 years in order to accumulate enough electricity to light an ordinary incandescent lamp for one second.

When were electric waves discovered?

The effect of an electric current on a magnetic needle (which is really, as we now know, an effect of the same kind as electric waves) was discovered by Oersted in 1819. Electromagnetic induction at a distance, the principle of the so-called magnetic detector, was discovered independently by Joseph Henry in the United States and by Michael Faraday in England in 1831. The theory that light is composed of electromagnetic waves was proposed by Maxwell in 1864. Such electric waves were actually produced experimentally by Hertz in 1888. It is this last date that is usually considered that of the first electric waves and the beginnings of radio, but the pre-

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vious discoveries were necessary preliminaries. Final experimental *proof* that light and electric waves are identical was not obtained until the experiments of Nichols and Tear in 1922. (See POPULAR RADIO for July, 1923).

What is the chemical composition of air?

Following is the composition by volume:

Oxygen	21.00	percent
Nitrogen	78.05	" "
Argon	.93	" "
Carbon dioxide	.03	" "
Neon	.001	" "
Hydrogen	.0003	" "
Helium	.00015	" "
Krypton	.00010	" "
Xenon	.00005	" "

All constituents are somewhat variable, especially the carbon dioxide. Traces of carbon monoxide, sulphur dioxide, ammonia, nitric acid and other gases are sometimes present.

It is reported that the recent eruption of Mt. Etna was accompanied by a large amount of "static" in near-by radio stations. Was this because the lava was charged electrically?

Probably not. We have seen no detailed scientific accounts of radio disturbances accompanying this eruption but the electrical effects of volcanic eruptions in general, including the usual lightning flashes that play about the erupting crater, are believed to be due to the clouds of dust ejected into the air. Some electricity is produced by friction between the dust particles. More is gathered, presumably, because the particles act as nuclei on which atmospheric electricity can collect. The result is that large charges accumulate in different parts of the cloud and are relieved by lightning flashes, with the usual accompaniment of radio disturbances.

Why will an electric dry battery quit working if you punch a hole in it?

A "dry battery" is not really dry. It contains a solution of sal ammoniac in water. That is what causes the chemical reaction inside the battery and produces the electricity. This solution is soaked up in paper or charcoal or some other material inside the battery and is sealed in by the asphalt or sealing-wax seal. If the battery is opened the solution evaporates and the battery really becomes dry inside. Then the necessary chemical reactions of the sal ammoniac solution cannot go on any more and no electricity is produced.

What is photoelectricity?

Some substances, when light falls on them, give off some free electrons, just as the filament of a vacuum tube gives off electrons when it is heated. Apparatus can be arranged to collect this electricity and measure it. It is called photoelectricity. There are a number of other effects of light on the electric properties of metals, for example, the change that occurs in the electrical conductivity of selenium when it is illuminated. Such "photoelectric effects" are among the physical phenomena now being studied most actively by the scientists.

What is the difference between stress and strain?

These two words are used in engineering language with perfectly definite meanings; both different from the loose use of these words in ordinary speech. The "strain," to the engineer, is the change in shape or size of anything when it is subject to force. The "stress" is the force that produces this change. For example, when you take hold of a knitting needle and bend it, the amount of bending is the *strain;* your muscular effort in doing so is the *stress.* Remembering this distinction will prevent much confusion in reading technical engineering literature.

Why is helium gas to be used in the new United States airships?

Because it will not explode. Helium is a chemical element belonging to the group of "inert" gases, so called because they will not combine with any other elements at all. The atoms of these gases are complete. There are no missing places where other electrons can be attached to the atom, as there are in other elements. Such attachments are what fasten atoms together and cause chemical combinations. Nearly all explosions are caused by some kind of chemical combination or decombination. The inability of helium to combine with anything is the reason why it cannot explode.

Is there any metal that conducts electricity better than copper does?

Silver is the only such metal. Under ordinary conditions and with the usual commercial metals a silver wire has about six percent less resistance than a copper wire of the same size. But much depends on the purity of the metal and on how well the wire was annealed when it was made. The following table gives the approximate conductivity of the common metals, copper being taken as 100 percent:

Aluminum	60
Copper	100
Gold	72
Iron	17
Lead	8
Nickel	13
Platinum	14
Silver	106
Tin	12
Tungsten	32
Zinc	27

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If you are getting good results with your receiving set, tell your fellow-readers of POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

WHAT A CRYSTAL FAN MADE AT HOME

A CRYSTAL set in De Walt, Texas, which receives programs from Denver and Memphis is described by Raymond Clift.

"On almost any clear night," he writes, "I can hear from five to twelve broadcasting stations with a home-made crystal set consisting of a variocoupler, a variable condenser, a fixed condenser, a crystal detector and a pair of phones.

"My antenna is a one-wire T type, 150 feet long and approximately 40 feet above the earth. Poor results with either a crystal or a tube are often due to a poor ground connection, I find. This is particularly true when only a short joint of pipe is driven into the earth for a connection. When the ground becomes dry a poor connection will result. I keep the earth around my ground connection in a moist condition and I think this helps my reception.

"My crystal detector is mounted on the wall and is connected into the circuit with flexible wire. By this means the crystal will not lose its adjustment easily when the instruments on my table are jarred. Instead of testing my crystal contact with a buzzer, I adjust it while a local station is broadcasting."

Some of the distant stations he has heard are WOC, Davenport, Ia.; WOAW, Omaha, Nebr.; KFAF, Denver, Colo.; KSD, St. Louis, Mo.; WOS, Jefferson City, Mo.; WMC, Memphis, Tenn., and a number which are closer.

* * *

ONE TUBE COVERS 2,300 MILES

WITH careful tuning of a single circuit, R. E. Jones, Jr., of Bay City, Mich., has heard a number of stations more than 1,000 miles away, his record distance being 2,300 miles. His set has only one tube but his log now includes 101 stations.

KPO of San Francisco, Calif., is the record station. Others are KFI, Los Angeles, Calif., 2,200 miles; CHBC, Calgary, Canada, 1,650; WCAK, Houston, Texas, 1,500; WPA, Fort Worth, Texas, 1,350; KFDF, Casper, Wyoming, 1,250; WWL, New Orleans, La.; WAAP, Wichita, Kansas, 1,034, and WKY, Oklahoma City, Okla., 1,000 miles.

* * *

DISTANCE WITH LIGHT WIRES FOR AN ANTENNA

LESTON W. BETTS of Hoboken, N. J., received from Chicago, Detroit and Omaha with a single tube and a plug in a lighting circuit for an antenna. His set is of the single-circuit type which as a rule sacrifices selectivity for distance and volume. He bases his success on the fact that he knows every "squeal" his set produces.

He hears WBAP of Fort Worth, Texas, which is 1,400 miles from Hoboken; WDAF, Kansas City, Mo.; KSD, St. Louis, Mo.; WMC, Memphis, Tenn.; WGM, Atlanta, Ga.; WLK, Minneapolis, Minn.; WMAQ, Chicago, Ill.; WWJ, Detroit, Mich., and WOAW, Omaha, Nebr.

* * *

THE COCKADAY CIRCUIT IN SUMMER

SOME of the stations John Gordon, Jr., of Rochester, N. Y., hears on his Cockaday Four-Circuit Tuner and two stages of amplification in summer weather are WAOW, Omaha, Nebr.; WLAG, Minneapolis, Minn.; WOC, Davenport, Ia.; WDAR, Philadelphia, Pa.; KSD, St. Louis, Mo., and WJAZ, Chicago, Ill.

Some of the stations were heard loud enough to operate a loudspeaker. He can receive from New York with his set when his local powerful station of WHAM is operating. He uses a UV-200 tube for a detector and a UV-201A for amplification.

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HE MAKES OLD ARMY SETS WORK

PROGRAMS from twenty distant stations come in through one tube in an old army set for C. E. Bogren of Washington, D. C. He used a dry-cell tube. An antenna eighty feet long brings in most of the powerful stations east of the Mississippi River.

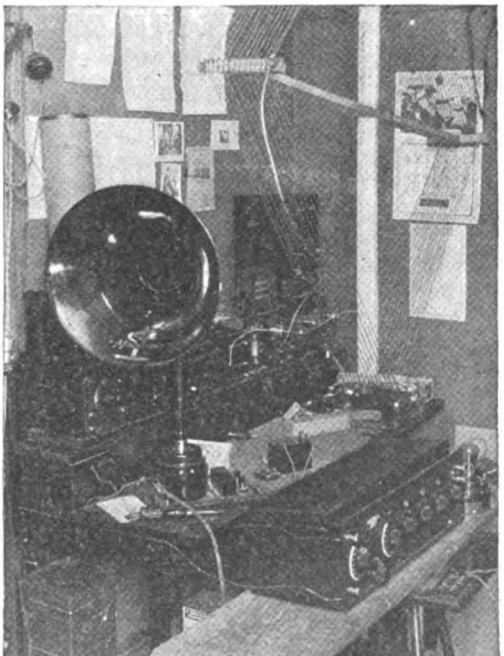
Some of the stations he hears are WSB, Atlanta, Ga.; KYW, Chicago, Ill.; WLW, Cincinnati, O.; WGF, Des Moines, Ia.; KOP and WWJ, Detroit, Mich.; WOH, Indianapolis, Ind.; WGI, Medford Hillside, Mass., and WAAQ, Greenwich, Conn.

* * *

IT SURELY DID "PERK"

"I MADE a 'Greene' receiver like the one described in the June issue of POPULAR RADIO," writes Willis L. Nye of Stockton, Calif., "and it surely did 'perk' on KPO, KHJ, KGW and all of the other stations within 200 miles of here. I made some changes which seem to improve it for me. I like my vernier condenser in the ground lead and my potentiometer for tuning. I have heard amateurs in the sixth, seventh, eighth, third and fourth districts, and I have heard broadcasting from Denver and Calgary.

"Using a wavetrap and one stage of audio-frequency amplification I have picked up everything west of Denver, south of Calgary and north of San Diego, and a number of stations beyond. My range on one tube includes 100 broadcasting stations."



Fred B. Teeling's station at Bath, Maine, with which he is able to pick up any of the broadcasting stations in the eastern half of the U. S.

RECEIVES BOTH LOCAL AND DISTANT STATIONS

"I WANT to let you know how pleased I am with my four-circuit tuner, made from your description in the May number. I have made a great number of sets but have never before been able to tune out the local stations and bring in "DX," writes A. F. Wheeler of New York City.

"The other evening while two of our most powerful local stations were broadcasting, WJZ and WOR, I received the following stations on my loudspeaker: WGY, Schenectady, N. Y.; WOC, Davenport Ia.; KOP, Detroit, Mich.; KDKA, Pittsburgh, Pa.; KYW, Chicago, Ill., and several others which were easier to tune in. I have also heard PWX, Havana, Cuba, while the local stations were operating."

* * *

SIMPLE PEANUT SET MAKES RECORD

USING a 43-plate condenser, a variocoupler and a plate variometer, Lee Epperhart of New Westminster, B. C., Canada, hears most of the western-coast stations with one dry-cell tube.

His list of stations, some of them over 1,000 miles away, include KHJ, Los Angeles, Cal.; KPO and KUO, San Francisco, Cal.; KGW, KGG and KFAB, Portland, Ore.; KFAU, Boise, Idaho; KFAE, Pullman, Wash.; KFAF, Denver, Col.; CFCN, CHBC and CFAC of Calgary, Alta., Canada, and CHBE of Victoria, B. C.

* * *

IN SPITE OF HOT WEATHER

WILLIAM E. SMITH writes to say that he received WEAF of New York at his home in Boston on a loudspeaker when the thermometer registered 90 degrees. He uses a Cockaday set with three tubes.

* * *

3,000 MILES WITH ONE TUBE

WITH only a detector tube, C. H. Anderson of Lewistown, Mont., has heard PWX of Havana, Cuba, about 3,000 miles away. He uses a variocoupler and two variometers in the ordinary regenerative hook-up.

* * *

FOUR TUBES PUT MAINE ON THE MAP

FROM the state of Maine and the city of Bath comes the report that four vacuum tubes can transfer that outlying community to the heart of Radio America. A regenerative circuit with a detector and three stages of audio-frequency amplification are used by Fred B. Teeling to produce many of the broadcast programs from the eastern and central states on a loudspeaker. He finds that a single wire 179 feet long works well as an antenna.

Some of his distant stations which show the best work of his set are WOU, Omaha, Neb.; WGH, Montgomery, Ala.; WCE, Minneapolis, Minn.; WBAA, Lafayette, Ind.; WAAO, Charleston, W. Va., and WWI, Dearborn, Mich. In the illustration below is shown a six-tube set which Teeling uses in his automobile, in connection with a loop antenna.

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WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from 50 to 300 words in length, the Editor will pay upon acceptance. Address contributions to the Editor,* ADVENTURE IN THE AIR DEPARTMENT, 9 *East 40th Street, New York City.*

I Go Up in the Air—and Get Married by Radio

SUPPOSE that you were a bride and that on your wedding day your groom were to lead you out before the waiting multitudes, strap you into an airplane, clap an earphone over your head, wave a signal to the pastor in a grandstand and whisk you up into the clouds to become his wedded wife by radio; by just how much would your thrill of getting married be intensified? Here's a reader who can tell us; she is one of a very few women in all the world to experience just exactly this particular adventure in the air:

I knew that the great event in a girl's life, her wedding, must be full of thrills. But to be married in an airplane, 3,000 feet up, and by radio, well. . . .

But to begin at the beginning:

My fiancé and I had planned an airplane wedding. It was to be a feature of the Twin Cities Air Derby at the State Fair grounds in Minneapolis. But my fiancé was an ardent radio fan and he insisted that his wedding would not be complete unless the ceremony was performed by radio. So performed by radio it was.

The wedding party, consisting of my husband-to-be and I, with my sister as bridesmaid and my father, motored to the fair grounds. There my bridegroom and I climbed into a large Spa plane that was equipped with both sending and receiving apparatus. Amid the cheers of the crowd we put on the headphones and made ready for our great adventure.

In the meantime the minister, the Rev. E. A. Jordan, of the First Congregational Church St. Paul, had gone to the judges' stand, where there was installed a broadcasting set with a microphone. The Sixth Infantry band struck up the wedding march from *Lohengrin*, the motor of the airplane began to buzz, and off we went. The adventure had begun.

I did not know a great deal about radio (I must confess that all the technical details I am giving have been supplied by my husband) and I expected to hear the minister almost immediately. But instead (and this was a thrill in itself, for I had never before been up in an airplane) we flew around for twenty minutes, looped the loop and did other spectacular stunts.

Finally the minister's voice began to come in. In the excitement of the moment I hardly knew what had taken place or what I was doing. I have thought since that it must have been even more exciting for my husband, for he had to operate the receiving and sending apparatus, and it was difficult to tune in while we were careening up there in the sky. Besides, he had to keep me from getting frightened, and when the proper time came he had to find the ring and put it on the right finger.

There were 10,000 people in the stands and large amplifiers had been placed so that the ceremony could be heard by all of them. My friends later told me that I said "I do" as if I meant it. Probably I did, but with so much excitement all at once my memory is somewhat hazy on that point.

I remember vividly, however, the applause we received as we came down; the cheers came in to us by radio long before we reached the ground.

I can truthfully say that my great adventure was indeed a "thrill that comes once in a lifetime," intensified 300 per cent.

—MRS. E. J. MOLINE

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I Listen In on a Great Moment of History

WHEN the word of peace was finally sent forth to the staggering world, following the parleys that immediately preceded the historic Armistice in 1918, among the very first to know the news, naturally, were the radio men. Here is a first-hand account of how Trooper Bronte picked a thrill out of the ether on that occasion:

The lights were out. Our sputtering candle had been doused long before. I sat in the darkness and fingered the receiver controls; shells falling near knocked the detector inoperative, as each thudding bellow shook the terrain. Bombs burst on the earth with a concussion which was like nothing I have ever heard.

I looked about at the feeble protection which covered the frame of the radio shack. No thickness of tarpaper which covered the walls and roof would stop any missile that struck; even a hundred thicknesses of it would be as paper. Back in the woods near the command post the explosions were growing more frequent, and a thin mixture of slow-moving gas stealthily went about its murderous business of seeking its prey in the dugouts.

Through the phones came the rough, coarse rasp of a spark coil in our lines. Somewhere close by was a German coil of extraordinary power splitting the ether, breaking up the coil signals from our trenches every time it opened up. It was deliberate and maddeningly efficient.

I tuned out this bedlam and went higher. Up to 1,800 meters I heard a faint rustle and going up "FL" burst in loud and clear above the hoarse roars of the explosions in the rear. I copied the words on a German military form under my hand in the darkness.

I called the adjutant on the field phone and read the words in French by the light of a match shaded by my hand. In its dull flicker I read words which meant the fall of two empires—the crashing of the most powerful military menace the world ever knew.

The message reported that an Armistice had been arranged, to take effect at 11 o'clock on the morrow, the 11th of November, 1918.

The wild thought surged through me that several million men would soon emerge from the mud and filth, vermin and dampness, from trench and dugout; several million men would lay down their steel and powder and breathe God's good air, and would soon be on the way back to some little town in Wyoming or Virginia or California.

The war was over!

—JACK BRONTE

THE ADVENTURE STARTS

Not only is this resolutely-smiling young woman about to take her first airplane flight, but she is about to be married by radio while still up in the clouds to the resolutely-smiling man beside her.

* * *

A Home-made Hero Borrows Some Glory

A GLIMPSE behind the scenes when Fate staged one of the most dramatic tragedies of maritime history is given in the following adventure sent in by an old-time radioman who spent eleven years in the navy. The man who first picked up the radio call for help from the *Titanic* was Harry Lang:

At the time the *Titanic* struck the iceberg in the Atlantic, back in 1912, and gave civilization a shock that even the World War has not belittled, I was on duty at Portsmouth, New Hampshire. My station, NAC, was the first to pick up the "CQD" (which was then the distress call) from the ill-fated liner. We answered at once, of course, and promptly called the revenue cutter that was anchored off Portland, Maine, and started her out to sea. Next we called another cutter at Boston and started her out similarly; then we called a navy cruiser stationed at Norfolk, Virginia. After that we assisted vessels near the *Titanic* by directing them to her latitude and longitude. Finally we notified the Boston *Herald*, which, of course, issued an extra on the information that we furnished.

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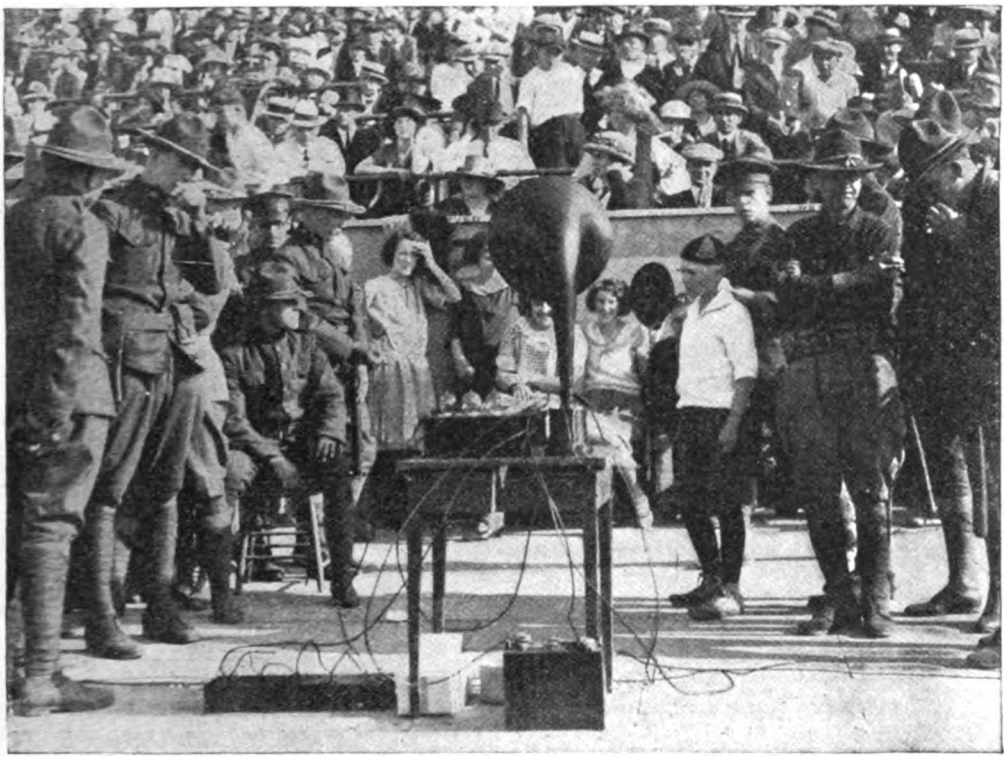

10,000 PEOPLE HEAR THE RADIO BRIDE ANSWER "I WILL"

At the moment the happy couple happened to be miles away, soaring through the clouds in a plane, and responding between loops to the wedding service conducted by a minister on the ground.

It was at this point that the amusing part of the story enters.

The paper asked for a photograph of the operator who picked up the call for help. We did not happen to have a picture of this particular operator in our station. I wanted to oblige, however, so I gave the newspaper reporter a picture of another chap who was connected with our station. Thus the unsuspecting unknown was made the hero of the occasion—even if he did not know it until he happened to pick up a paper in another city and read all about it!

—THOMAS BAKER

* * *

Cupid Rides the Ether Waves

HERE'S a chap in College Park, Georgia, who gets us all excited about a romance by radio—and leaves us in suspense about the outcome:

It was a warm June night, during my vacation, when the indefinable came riding through the regenerative circuit on chariots of electromagnetic waves. As the waves were continuous, I adjusted the tuning on the one-tube set to perfection and listened to a broadcasting station from my own home town.

All at once my heart thumped when it was announced that "the next number would be a song by Miss Blank." We had both graduated from high school in the same class; I had not been entirely immune to her charms. I had not thought seriously about her before, but as she began to sing I began to vision her as the most beautiful and desirable girl in the world. I became so absorbed in her recital that I fear my co-hearers detected it.

When she finished I found that I had lost interest in the rest of the program. And that night I wrote to her.

—WALKER L. CURTIS

* * *

I Get a Thrill from an Uncoded Message

FROM a veteran of the Radio Section of the Signal Corps comes this evidence that all of the excitement in the A. E. F. did not end with the Armistice—even in the ether:

I was on duty in Germany with the Signal

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"I PRONOUNCE YOU MAN AND WIFE"

So announces Pastor Jordan, who is here seen at the conclusion of the ceremony that united a couple in a far-off airplane. As evidence of the sporting quality of the occasion he is using as a pulpit—and radio station—the judges' stand at the State Fair grounds.

Corps of the American Army. The ether was practically silent. I was sitting in a great chair consuming a supply of golden brown waffles, which (needless to report) did not come from the headquarters company kitchen, but from the kitchen of the German house in which we had erected our radio station. A robust young peasant girl had climbed three flights of "high inductance" stairways to bring them to me. The war was over. The waffles were fine and the coffee was hot; altogether it was a gay old life for a *soldat* stationed in a hostile country.

Suddenly a rasping coil broke up my business at hand. I copied the signals with consternation. The more I copied the more astonished I became.

" . . . Three thousand enemy infantry are crossing the ford and are headed for X. Hurry to meet them. Artillery will support you. (Signed) Warner, 1st Brigade."

So the Germans were in revolt! Already they had amassed forces and probably were sweeping through the sparsely occupied country. Why had not we been notified? I leaped to the window, expecting to see the batteries prepared for action or on the march. All I saw were three German soldiers who were talking idly with a girl across the road. An M.P. was dozing at the corner. Were the enemy on the advance? Were these the advance guard idly gossiping with the women? Where was the colonel? What was headquarters doing about this enemy advance? I became panic-stricken at the thought of a plot that would conceivably sweep our brigade into the back areas or annihilate it on the spot. I must act quickly.

I grasped the field phone that hung by the receiver. The telephone operator in the exchange down the street answered my insistent buzzer.

"Just a minute, OM," he said, and he said it with exasperating calmness.

"Minute? Hell!" I roared in the phone. "Connect me with the radio officers' billet and do it quick."

"Hold your animile," came back the blithe reply. "We are busy here with practice manœuvre messages. . . . Yes, Yes!" went on the operator in a mild voice, speaking to someone else on the line. "All right! Three thousand infantry. Yes, go on, OK. . . ."

I banged the telephone on the table. So all that I had heard were practice messages relating to practice manœuvres! It certainly was a let-down.

I took up again the important work of stowing away the waffles. But I wanted to get my fingers under the ear lobe of the second "Looie" who failed to put that radio message in code, as he certainly should have done.

—JACK BRONTE

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"Here's the panel I want"

THE panel is the "front door" of your radio set. The selection of the panel is an important step. You want a good-looking panel. And you want a panel that has high dielectric strength.

Your Celoron panel comes wrapped in a dust-proof glassine envelope. Dust and grit cannot scratch it. Human hands cannot leave greasy finger-prints on it.

Because of its high dielectric strength, Celoron, a bakelite product, is approved by the U. S. Navy and the U. S. Signal Corps.

Celoron radio panels are finished in *black, oak and mahogany.* They come ready to use in these standard sizes:

1—6 x 7 x 1/8	5— 7 x 18 x 3/16
2—7 x 9 x 1/8	6— 7 x 21 x 3/16
3—7 x 12 x 1/8	7— 7 x 24 x 3/16
4—7 x 14 x 3/16	8—12 x 18 x 3/16
	9—7 x 26 x 3/16

Other sizes are cut to order from sheet Celoron. *Ask your dealer.*

An interesting booklet for the radio set builder is "*Getting the Right Hook-Up.*" This booklet is sent *Free* upon request.

To radio dealers: Send for special dealer price list showing standard assortments

Diamond State Fibre Company

BRIDGEPORT (near Philadelphia) **PENNSYLVANIA**

Offices in Principal Cities
In Canada: Diamond State Fibre Company of Canada, Limited, 245 Carlaw Ave., Toronto

CONDENSITE CELORON STANDARD RADIO PANEL

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Equal to All Demands

THIS IS NUMBER FOUR OF A SERIES

Every tube you add to your receiver makes it just that much more important for you to use Eveready "B" Batteries, for each additional tube increases the work the "B" battery has to do. It demands a more capable, long-lived battery.

Here is a table that shows just what each type of receiving tube draws from your "B" battery. The current is measured in milliamperes, or thousandths of an ampere.

Current (in milliamperes) Taken from the "B" Battery by Various Tubes

"B" Volts	WD-11 WD-12	UV-199 C-299	UV-201 C-301	UV-201-A C-301-A
22½	0.5	0.5	0.5	0.5
45	1.5	1.4	1.5	1.5
67½	2.5	2.4	2.5	3.5
90	4.5	4.0	3.9	6.0

Above figures are at zero grid bias

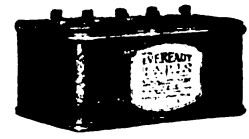
The table shows that the "B" battery current drain increases much more rapidly than the increase in voltage. For example, if the voltage doubles from 45 to 90, the current drain increases threefold in one case and fourfold in another case. This all means that the life of the "B" battery may be materially lengthened by not using a higher voltage than is necessary to obtain the desired results.

The most popular type of receiver today has at least three tubes, operating a loud speaker. As ordinarily employed, it places a fairly heavy drain on the "B" battery.

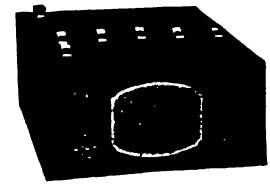
Under light and heavy service, Eveready "B" Batteries prove up. More and more fans buy them every day because they are the most economical. According to the work they have to do, so is their life.

You get most energy for your money in Eveready "B" Batteries—*they last longer.*

"the life of your radio"



The Metal Case Eveready "B" Battery No. 766. The popular 22½-volt Eveready Battery in a *new*, handsome, durable, waterproof metal case. At all dealers, $3.00.



Eveready "B" Battery No. 767. Contains 30 large size cells, as used in the popular No. 766. Voltage, 45. Made especially for sets using detector and one or more stages of amplification. The most economical "B" Battery where 45 volts are required. At all dealers, $5.50.

Eveready Radio Battery No. 771. The Eveready "Three," the ideal "C" Battery. Voltage, 4½—three terminals permitting the use of 1½, 3, or 4½ volts. The correct use of this battery greatly prolongs the life of the "B" Battery. At all dealers, 70 cents.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, INC.
Headquarters for Radio Battery information
New York, N. Y.

EVEREADY
Radio Batteries
—they last longer

NOTE—*This is No. 4 of a series of informative advertisements, printed to enable users to realize the utmost in battery economy. If you have any battery problem, write to G. C. Furness, Manager, Radio Division, National Carbon Co., Inc., 128 Thompson Avenue, Long Island City, N. Y. Ask for special booklets on "A", "B" and "C" batteries.*

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"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"

When Radio called, Eveready was ready

TWENTY-ONE years ago, when wireless telegraphy had its first birthday, National Carbon Company's dry cell batteries were nine years old. Even then, its batteries were world famous as convenient, economical and efficient sources of electric energy.

With the introduction of popular broadcasting, radio leaped into universal service. Radio engineers used Eveready Batteries as their standard in designing tubes and receiving sets. Eveready engineers, backed by the most complete research and testing laboratories known to the industry, worked with them to discover how the known dry cell could be improved for radio work.

The fruit of these efforts is the Eveready family of radio batteries conspicuous for vitality and endurance—the right battery by test and proof for every radio use.

Insist on Eveready Batteries—they last longer.

Informative and money-saving booklets on Radio Batteries sent free on request.

NATIONAL CARBON COMPANY, INC.
New York, N. Y.

Headquarters for Radio Battery Information

If you have any battery problem, write to RADIO DIVISION, NATIONAL CARBON COMPANY, INC.
128 Thompson Ave., Long Island City, N. Y.

Eveready "B", 22½ volts, No 766 with Six Fahnestock Spring Clip Connectors

Radio has moved from the laboratory and amateur's work-table out into the refined surroundings of the family living room. In keeping with this new companionship we offer this reliable, long-lived Eveready "B" Battery, in an attractive, new metal case, worthy to stand beside the rich cabinets of fine radio sets.

EVEREADY
Radio Batteries
—they last longer

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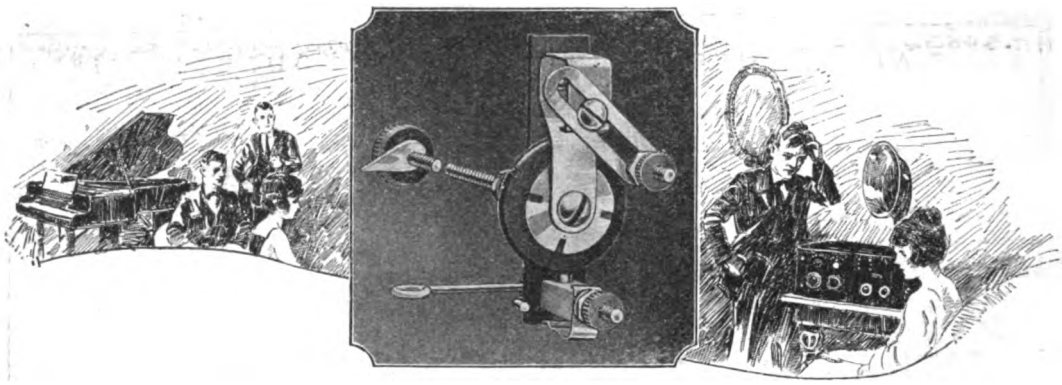


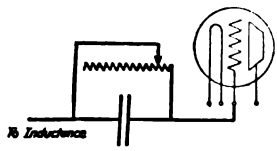
He Tried a New Tube—and Then Learned the Secret of Grid Control

Many Sets Can Have Increased Range and Better Reception Through Proper Control of the Grid Condenser

He was a careful buyer. He knew the folly of using cheap equipment in his set—for precision decides between results and failure in radio. And he built carefully.

But when the set was finished he had only fair results. The distant stations that he wanted could not be heard consistently. And when they were tuned in, they *faded*, so that adjustments had to be made continuously. At times the program would die away and be lost. At others, there was a distinct clicking heard, with alternate periods of clear and muffled reception.

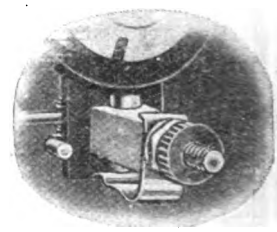
His friends said the set was not *stable*—and there were as many suggestions for corrections as there were friends. But each time the circuit was checked it showed no wrong connections. Every joint was soldered, every binding post tight.



Unless a "Leak" of the proper resistance is placed across the grid condenser, the tube will either choke or the effect of the condenser be destroyed. The value depends on both the characteristics of the tube and the circuit—it can be obtained only in an accurate variable grid leak of proper design.

Then one day his detector tube passed into the great beyond from which no tube returns. And it was then that he learned the secret of his poor results.

With a new tube the set produced perfect concerts—tones clear and natural—fading and clicking were eliminated. Like a flash he realized that the characteristics of this new tube were better suited to the constants of his circuit. To prove it he tried another tube—of exactly the same type. And again his results were better. Stations he had never received before could be heard, and those that he had copied only on perfect nights could be tuned in at will. His lack of control of the grid condenser cost months of unsatisfactory reception.



The carefully milled rotor of the C-H *Variable Grid Leak constantly accumulates graphite from the specially prepared brush, reducing the resistance of the leak. If this becomes too low for the tube used, merely wiping the rotor with a clean cloth restores it to a high value for readjustment.*

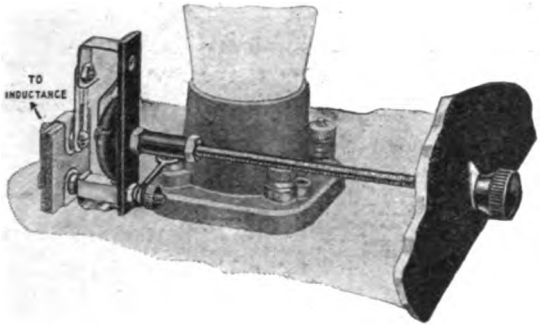
Are Your Results Choked Off in the Grid Condenser?

For every tube and for every circuit there is a certain value of resistance that allows the charge which "piles up" on the detector grid to "leak off" at just the proper rate. If this value is too high the charge

C-H CUTLER-

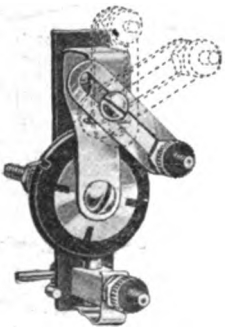
Digitized by Google

accumulates, and the tube chokes—if too low, reception is "mushy," in some cases the grid condenser cannot function at all. Therefore, the *Grid Leak* must be of variable resistance to adapt itself to the characteristics of the circuit in which it is expected to operate. To insert a *fixed* leak is merely a gamble—a chance against large odds of hitting the proper value with all the results of your set at stake.



Put a C-H Variable Grid Leak in Your Set and Be Certain of Maximum Efficiency

The C-H Grid Leak is worthy of the trademark it carries. It was designed by the master builders of all electrical control apparatus, and is produced with watch-like precision to give accurate control. It can be installed in a few minutes in any set. A special flexible mounting link makes it easy to attach directly to the grid terminal of the tube socket or wherever else desired. A long, fully threaded brass control rod (which can be cut to any length required) is furnished with bakelite insulating joint, Thermoplax knob and pointer for panel control. The leak is adjustable, arranged to care for any style of grid condenser.



The C-H Variable Grid Leak is fully adjustable for all styles and sizes of grid condensers.

Install one in your set tonight for better, clearer, more consistent reception. No wiring is required. Attach it to the grid terminal of your tube socket, and attach the wire you removed from that post to the one on the Leak marked "to inductance." Carried by jobbers and dealers everywhere. Sample can be obtained direct from factory at list price, $1.50 plus 10c for wrapping and postage.

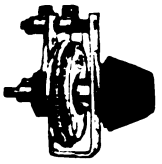
THE CUTLER-HAMMER MFG. CO.

Member Radio Section
Associated Manufacturers of Electrical Supplies

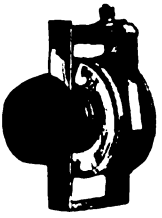
MILWAUKEE, WISCONSIN

C-H

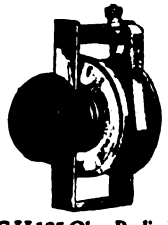
Instruments of Guaranteed Quality Assure Success in Radio



The C-H 4 Ohm Vernier Rheostat—*Perfect detector tube control. Also furnished without vernier for amplifier tube control.*

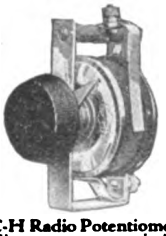


The C-H 30 Ohm Radio Rheostat—*For control of the ¼ ampere, "UV201A-C301A" type receiving tubes and the "UV199-C299" type.*



The C-H 125 Ohm Radio Rheostat—*The rheostat that makes it possible to use a 6V storage cell with the UV199 or C299 tubes.*

The C-H Variable Resistance Unit—*Attach it to your present 4 ohm rheostats to obtain the required 30 ohms for the new tubes.*



The C-H Radio Potentiometer—*The potentiometer with the resistance unit that does not wear and cannot be displaced under constant usage.*

HAMMER

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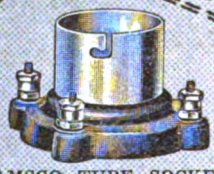
CALGARY

AMSCO

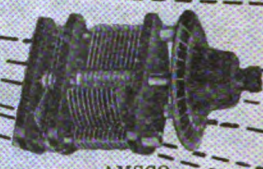
PORTLAND

HAVRE



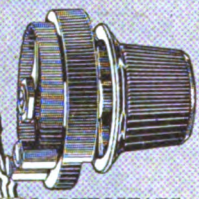
AMSCO TUBE SOCKET

Base of highly polished Condensite. Nickeled brass sleeve.



AMSCO
VERNIER CONDENSERS

Precision made, for accurate tuning.



AMSCO RHEOSTATS
AND POTENTIOMETERS

Suitable for either table or panel mounting.

DENVER

LOS
ANGELES

The Vitreous Enameling Co.
GRANT AVE. NEAR E. 71 STREET
CLEVELAND

November 14, 1925

Benjamin B. Price, President
Amsco Products Company
New York, N. Y.

Dear Mr. Price:

Your AMSCO Supreme Receiver is startling in its efficiency. The following four points make it the ideal receiver for the home:

1. EASE OF TUNING. It is a wave meter. Dial settings for given wave lengths are always the same, and the whole dial range is used from 200 to 600 meters, as shown by attached chart.

2. RANGE. I have tuned in as many as 30 different broadcasting stations in a single evening. In six evenings, 60 stations were tuned in, including KFAF, KLZ, KHJ, and 6KH. These 60 include every station in Radio Digest's list entitled "In Evening At Home With The Radio", except four, namely, Calgary, Montreal, Portland, and San Juan.

3. SELECTIVITY. WJAX, Cleveland, 390 meters, can easily be tuned out, and WGY, Schenectady, 380 meters, tuned in. Using compensating condensers, distance stations on same wave length can be entirely separated.

4. VOLUME. On non-power loud speaker, using 25 foot indoor aerial, stations in crystal distance can be heard without audio amplification; stations within 1500 miles, using the single stage audio frequency. The western and Pacific coast stations are clear and loud in phones without audio amplification.

Your success with this receiver is indeed merited.

Sincerely,

Vice-President

Write for Complete Descriptive Literature.

AMSCO PRODUCTS, Inc.

FAIRBANKS BUILDING

BROOME & LAFAYETTE STS. NEW YORK CITY

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MELCO

SCHENECTADY

DETROIT

CHICAGO

CLEVELAND

PITTSBURGH

DAVENPORT

CINCINNATI

JEFFERSON CITY

MELCO SUPREME

The Tuned Radio-Frequency Amplifying Receiver that—

Operates with merely a 10 FT. WIRE—not even a ground necessary.

Offers exceptional CLARITY without the slightest loss of tone quality.

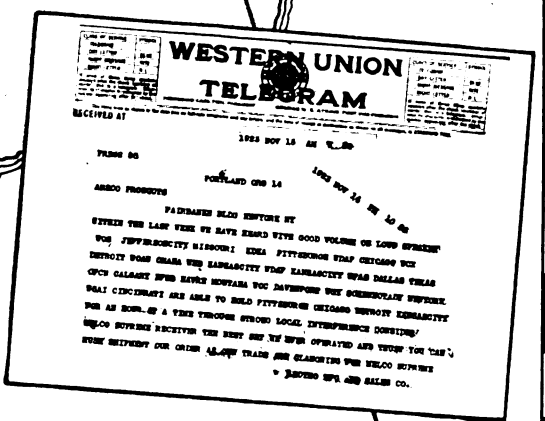
Insures unusual program SELECTIVITY through its single tuning adjustment.

Affords real LONG DISTANCE by covering all Broadcasting ranges from 180 to 610 Meters.

PRICE ONLY $140

Complete knock-down parts for Melco Supreme including drilled engraved Bakelite panel and solid mahogany cabinet.

Price $90.00



WESTERN UNION TELEGRAM

RECEIVED AT

1925 NOV 15 AM

PRIMS 86

PORTLAND ORE 14

AMSCO PRODUCTS

FAIRBANKS MELCO RENTURE ST

EITHER THE LAST WERE WE HAVE HEARD WITH GOOD VOLUME OR LOUD SPEAKER

FROM JEFFERSONCITY MISSOURI IOWA PITTSBURGH WHAP CHICAGO WCX

DETROIT WOAW OMAHA WHO KANSASCITY WDAF KANSASCITY WOAW DALLAS TEXAS

KPCB GALLANT KFKB SALT MOUNTAIN UTAH DAVENPORT WOC SCHENECTADY WGFNRL

WGAI CINCINNATI ARE ABLE TO HOLD PITTSBURGH CHICAGO DETROIT KANSASCITY

FOR AN HOUR OF A TIME THROUGH STRONG LOCAL INTERFERENCE DOWNING

MELCO SUPREME RECEIVES THE BEST SET WE HAVE OPERATED AND THANK YOU THE

SOUTH DAKOTA OUR ORDER ALSO TRADE AND CLERKING THE MELCO SUPREME

J. FAIRBANKS MFG. AND SALES CO.

AMSCO PRODUCTS, Inc.

FAIRBANKS BUILDING

BROOME & LAFAYETTE STS. NEW YORK CITY

TUNICU

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The Supreme Insulation

RADION

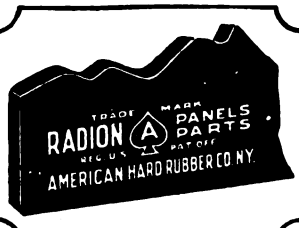
Panels

are easiest to drill, saw, or engrave with simple tools at home

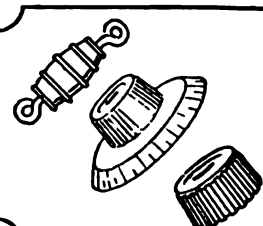
18 Stock Sizes Radion Panels

Black and Mahoganite

6 x 7	6 x 10½	6 x 14
6 x 21	7 x 9	7 x 10
7 x 12	7 x 14	7 x 18
7 x 21	7 x 24	7 x 48
9 x 14	10 x 12	12 x 14
12 x 21	14 x 18	20 x 24



Look for this stamp on every genuine RADION Panel. Beware of substitutes and imitations.



AMERICAN HARD RUBBER CO., 11 Mercer St., N. Y.

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Radio Broadcast Contest reveals Bradleystat supremacy for Long Distance Reception

RADIO Broadcast recently conducted a prize contest, open to all radio enthusiasts, for the purpose of interesting amateurs in long-distance reception. Ninety contestants were entered, and the names of all, including prize winners, were published in several issues of Radio Broadcast, after the contest closed.

How the remarkable Bradleystat records were discovered!

AFTER the names were published, a letter was written by the Allen-Bradley Co. to each contestant to ascertain what filament rheostat was used in each radio set. Seventy-two reports were received, and after they were tabulated, the most amazing discoveries were made about Bradleystat performance and Bradleystat popularity.

$1.85

IN CANADA **$2.50**

PARCEL POST 10¢ EXTRA

The Bradleystat captured first place in all leading events!

The superiority of the Bradleystat was proved, conclusively, by these facts:

1. The First Prize Winner used the Bradleystat in his set.
2. The greatest mileage record of 305,420 miles, total, was made by a Bradleystat user.
3. The Bradleystat was the most popular rheostat in the entire contest.
4. More Bradleystats were used than the next four types of rheostats, combined, "see diagram."
5. No carbon or metallic powder rheostat was reported in competition with the Bradleystat in this record-breaking contest.

Your radio set needs a Bradleystat. Try one tonight!

Bradleystat Leads by Big Margin

Analysis of Returns

Each line represents a different type of rheostat used in the contest. The numbers indicate how many of each were used. Now the overwhelming popularity of the Bradleystat, first on the list.

Allen-Bradley Co.
Electric Controlling Apparatus

276 Greenfield Avenue — MILWAUKEE, Wisconsin

THE ALLEN-BRADLEY CO. HAS BUILT GRAPHITE DISC RHEOSTATS FOR OVER 20 YEARS

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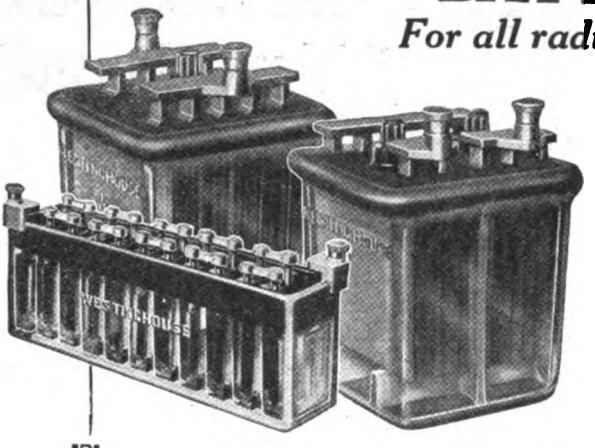
WESTINGHOUSE

CRYSTAL CASE "A," "B" and "C" BATTERIES

For all radio requirements



Better Batteries— Better Radio Reception

Every radio fan knows the importance of sustained battery voltage in a radio receiving set. A sudden drop in filament voltage, for example, is exasperating. Right here the name Westinghouse becomes significant. As in automobile batteries, Westinghouse Radio Batteries are the finest Westinghouse can build. The new CRYSTAL CASE types are especially efficient. Even-powered, slow-discharging, you'll quickly note their superiority for fine tuning, signal holding and sound volume. So economical, too! They last indefinitely and are easily recharged at a few cents' cost.

CRYSTAL CASE *"A" Batteries*—One-piece glass case with solid glass cell partitions and plate rests. Visible interior. 2, 4 and 6-volt sizes. CRYSTAL CASE *"B" Batteries*—The 22-MG-2 (22 volts) is a wonder for steady, noiseless, full-powered service. Rechargeable, of course. Larger types, too. Also "C" batteries in 6-volt units.

WESTINGHOUSE UNION BATTERY CO.
Swissvale, Pa.

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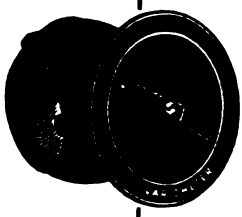
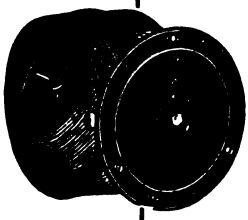
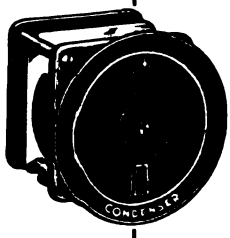
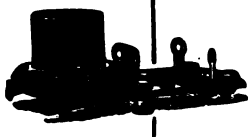
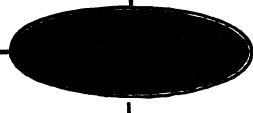










Build your own Radio Set

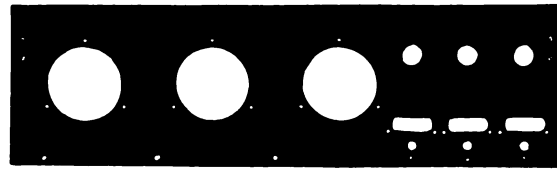
—and save half the labor customarily involved.

The panels are completely drilled, and the parts are simply fastened with screws and nuts.

Any circuit desired may be employed. We have eight different types of panels.

The crystal black panel finish, together with the concave dials, lend a pleasing effect—the absence of knobs giving a clean, flush appearance.

You can build, or buy, a cabinet to suit your individual taste.



Illustrated catalog upon request

EISEMANN MAGNETO CORPORATION

William N. Shaw, *President*

46-33rd STREET, BROOKLYN, N. Y.

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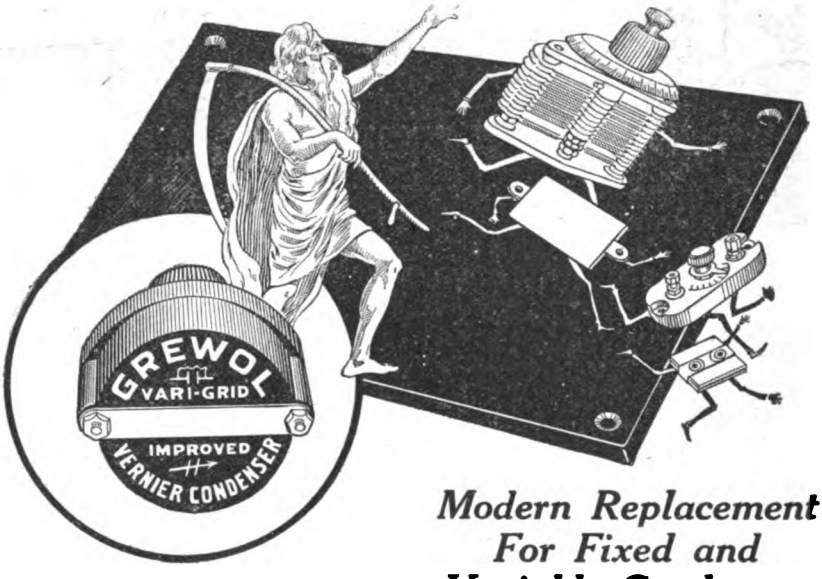

Modern Replacement For Fixed and ***Variable Condensers***

The GREWOL Vari-Grid

Used as a 11 or 23 Plate Vernier Condenser as well as a variable grid control.

The capacity of the grid of your tube **must** be varied to secure maximum efficiency, distance, clearness and sharp tuning. This is the purpose of the Grewol vari-grid.

Equipped with grid leak, removable when Vari-Grid is used as vernier condenser in other circuits than the grid. Costs less! One hole to drill 1¾" in diameter, an efficient quality instrument. Write for descriptive booklet.

PRICE $2.25

GREWOL Fixed Detector

Positive, sensitive adjustment **ALWAYS,** instead of continual guessing and adjusting. Therefore, preferred for all reflex and other super-sensitive circuits. Glass-enclosed, solid mounting (vibration-proof). Adds to the appearance of your set, imitated but never equalled. Others cost more but none give better satisfaction.

PRICE $2

(Actual Size)

Each detector equipped with Special Reflex Crystal, guaranteed not to burn out

WRITE FOR NEW REFLEX HOOK-UP FREE

Both of these GREWOL Products At Your Dealers or Direct Upon Receipt of Price

RANDEL WIRELESS CO.

4 CENTRAL AVENUE ∴ NEWARK, N. J.

Jobbers and Dealers write for Proposition

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The Music of the Immortals in Your Own Home

People sometimes sit hours in hot, stuffy opera houses to hear our famous opera singers. Yet the immortal notes of those same stars are broadcasted from radio stations and are listened to by thousands in the comfort and seclusion of their own homes.

Perhaps you would rather follow an athletic contest play by play, or listen to a speech by some famous man. Or perhaps the market, crop and weather reports would prove more interesting to you.

PARAGON

Reg. U.S. Pat. Off.

RADIO PRODUCTS

With the new PARAGON Three-Circuit Receiver Type RB-2 you can pick out the program you wish to hear and hear it clearly from beginning to end. For the greatest enjoyment of radio, for complete satisfaction, you should listen in with a Paragon set.

In appearance it is an addition to any home. All cabinet work is of mahogany with a brown mahogany finish. All metal parts showing, inside as well as outside of the cabinet, are nickel plated. 98% of the wiring is invisible. The whole outfit is compact, neat, solidly built, and finely finished. It is the ideal Radio receiver and the ideal holiday gift.

Illustrated Bulletins on Paragon Radio Products Are Yours for the Asking.

DEALERS: We believe in the proper distribution of Paragon Radio Products. Our exclusive Distributors are particularly interested in territorially protected dealers, who will concentrate, solicit and serve the consumer in the sale of Paragon Radio Receivers. If interested, write us for details.

ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.

Illustration shows the new Paragon RB-2 Regenerative Receiver with two-stage tone amplifier Price $135.00

(Licensed under Armstrong Patent No. 1,113,149)

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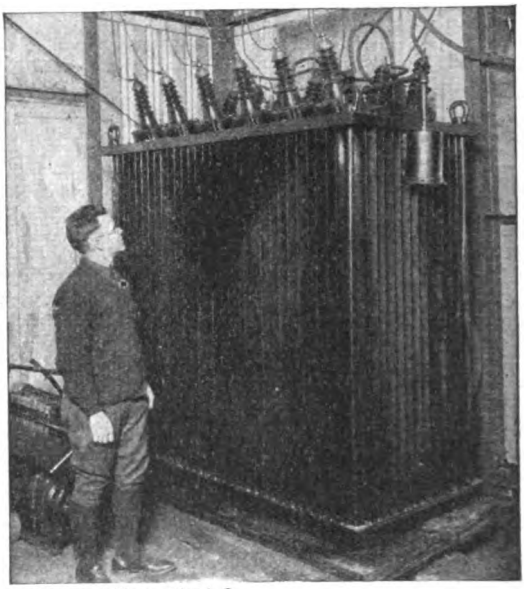
A real contribution to Radio Progress

The photograph at the right illustrates the special service transformer installed at the Radio Central, Rocky Point, L. I., for talking across the ocean.

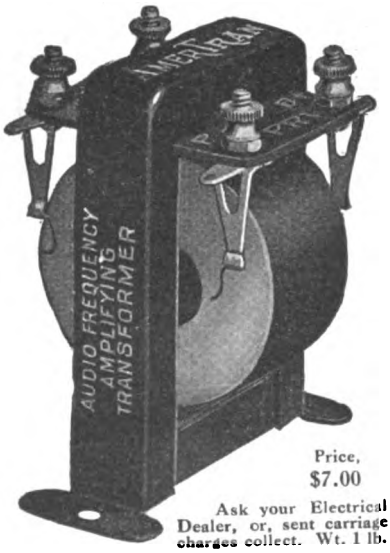
It represents a long step forward from the pioneer days, over 20 years ago, when we also equipped the stations of the Marconi Company with the large transmitting transformers for the first commercial transatlantic wireless communication.



By Courtesy of Western Electric Co.

300 k.v.a., 60 cycle, 3-phase, 22,000 volt, oil-cooled special service transformer, Radio Central, Rocky Point, L. I.

—With all tubes— **AMERTRAN** TRADE MARK REG U.S. PAT. OFF. *—In all stages—*



Price, $7.00

Ask your Electrical Dealer, or, sent carriage charges collect. Wt. 1 lb.

This experience in transformer design and construction has produced The AmerTran — an audio frequency transformer for the amateur and professional alike.

Its flat-top distortionless amplification curve assures a pure tone rendering of the full musical scale.

It amplifies in one stage from 30 to 40 times in the flat part of the curve, depending on the tube constant — the amplification is approximately 5 times the tube constant.

In One Type Only. Turn Ratio, 5:1

American Transformer Company

Designers and builders of radio transformers for over 22 years

181 Emmet Street :: Newark, N. J.

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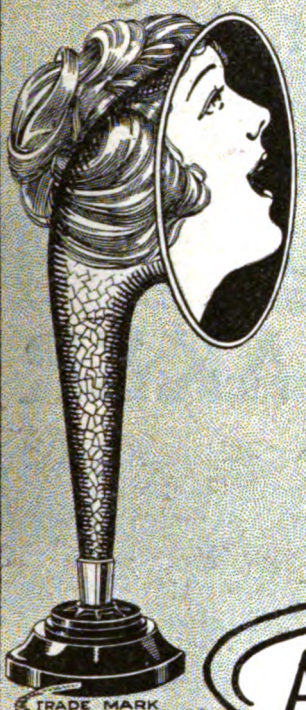
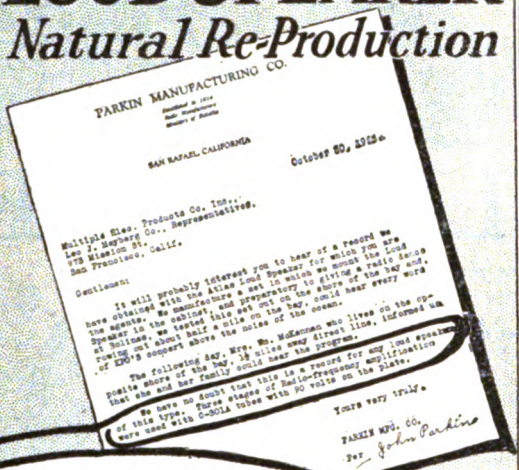
Atlas LOUD SPEAKER

Natural Re-Production




PARKIN MANUFACTURING CO.

SAN RAFAEL, CALIFORNIA

October 20, 1923.

Multiple Elec. Products Co. Inc.,
Leo J. Hayberg Co., Representatives,
172 Mission St.,
San Francisco, Calif.

Gentlemen:

It will probably interest you to hear of a record we have obtained with the Atlas Loud Speaker for which you are the agents. We manufacture and prepare to ship a radio device to Bolinas, we tested this set out on the bay and, rowing out about half a mile on the ocean. Speaker in the cabinet into a set out on the shore of the bay and, at Bolinas, we could hear every word of KPO's concert above the noise of the ocean.

The following day, Mrs. Mc. McKennon who lives on the opposite shore of the bay, 18 miles away direct line, informed us that she and her family could hear the program.

We have no doubt that this is a record for any loud speaker of this type. Three stages of Radio-Frequency amplification were used with C-301A tubes with 90 volts on the plate.

Yours very truly,

PARKIN MFG. CO.
Per John Parkin

A Record!

ENTHUSIASTIC TESTIMONY straight from an impartial authority. RE-PRODUCTION is a *fact*. The delicate overtones which give music its roundness, resonance and timbre, are faithfully re-born through the modern magic of the patented "double diaphragm." This extremely responsive device is adjustable to the exact requirements of your set and individual receiving conditions. *Write for Illustrated Booklet* "B"

Atlas Loud Speaker Unit

With Phonograph Attachment $13.50
Without Phonograph Attachment . . . $12.50

Letters From Users Requested

What have you accomplished with your Atlas Amplitone? Tell us about it.

Sole Canadian Distributors
The Marconi Wireless Telegraph Company of Canada, Limited

Ask Your Dealer for a Demonstration

List Price Complete

$25

Multiple Electric Products Co. Inc.

ORANGE ST., RADIO DIVISION NEWARK, N. J.

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New 1924 Model

Pathé

LOUD SPEAKER

Mahogany Finish

Price Now

$17.50

(West of Mississippi $19.00)

See It Today

Step into your dealer's store—he will gladly give you a demonstration without obligation. See this wonderful new value, placed on the market now for the first time. You will realize the outstanding superiority of the new Pathé Loud Speaker. Notice its beautiful Mahogany finish and its ability to reproduce long distance signals clearly. With the new low price it is the best buy on the market.

FREE PAMPHLETS

Write now for free pamphlets on the Pathé Loud Speaker, Pathé Variometer, Pathé Variocoupler, Pathé Dials and the new Curtantenna.

Jobbers and dealers write for new special proposition

PATHÉ PHONOGRAPH & RADIO CORPORATION

20 GRAND AVE., BROOKLYN, N. Y.

Western Sales Office, 533 Wabash Ave., Chicago, Ill.

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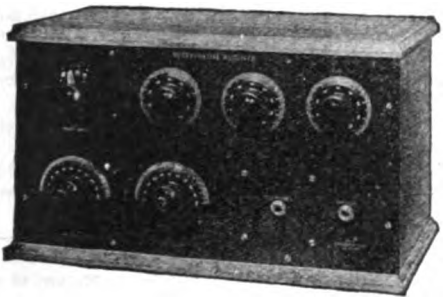
C

·NATIONAL·

CHELSEA

LEADERSHIP THRU QUALITY AND COMPLETE LINE

Performance!—*Read this Letter*



Receiver No. 102
PRICE, $95.00
(Licensed under Armstrong Patent 1113149)

Audio Frequency Transformer, No. 50
Gives maximum amplification without distortion
Ratio 3¾ to 1. Moisture proof
PRICE, $4.50

Vernier Variable Condenser, No. 10
Twenty-three plates, capacity .0005 M. F. Built-in vernier—low resistance and losses.
PRICE, $4.50

Melrose, Mass., November 10, 1923.

National Chelsea Radio Corp., Boston, Mass.

Gentlemen: I know that you will be interested in the remarkable reception which I obtained with one of your Type No. 102 Regenerative Receivers.

I received the instrument Friday, November 2, and connected it in the presence of two of the Boston Edison Company's engineers. On this evening without any previous experience, I heard practically every station throughout the Middle West on a loud speaker. I am very much delighted with the performance of this receiver.

I am attaching below a list of stations which I have heard during the past six days. All of these stations were received on the loud speaker with sufficient volume to be heard all over my home with the exception of Denver. Nearly all of these were received prior to 10 p.m.

WOC	Davenport	WJZ	New York City
WOAI	San Antonio	WOS	Jefferson, Mo.
KLG	Denver	WCAU	Phila., Pa.
WHN	New York City	WFI	Phila., Pa.
KHJ	Los Angeles	WNAC	Boston
WFAA	Dallas	WGI	Medford
WDAR	Phila., Pa.	WDAP	Chicago, Ill.
KDKA	Pittsburgh, Pa.	WTAM	Cleveland, Ohio
WRC	Washington, D. C.	WLAG	Minneapolis, Minn.
WEAF	New York City	WHW	Cincinnati
WOR	Newark	KQW	Pittsburgh
CFCF	Montreal	WIP	Phila., Pa.
WGY	Schenectady	WCAE	Pittsburgh
WBZ	Springfield	WWJ	Detroit
WHAZ	Troy, N. Y.	KYW	Chicago
WCBD	Zion, Ill.	WDAP	Chicago
WAAM	Newark, N. J.	WSB	Atlanta
WGR	Buffalo	KSD	Kansas City
		WHAS	Louisville

Assuring you that I am an enthusiastic booster of Chelsea Receivers I remain,

Yours very truly,

AUBREY R. GOODWIN.

You can secure the same results with this wonderful Chelsea Receiver.

CHELSEA PARTS

The marvelous results obtained by **CHELSEA RECEIVERS** are largely due to the Chelsea Parts. If you are building your own set you may be certain that the use of Chelsea Parts will give you the maximum results.

Write for our large Catalog No. 3 illustrating a complete line of sets and parts

NATIONAL CHELSEA RADIO CORP
739 Boylston St., Boston, Mass.

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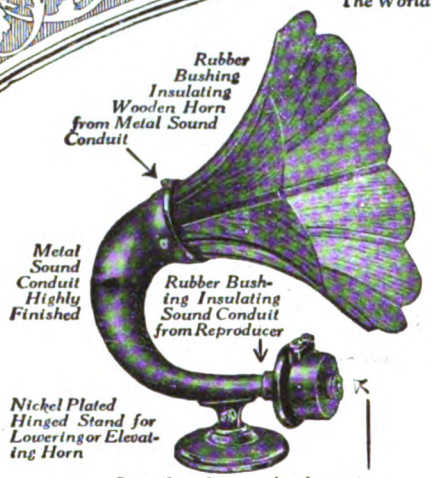
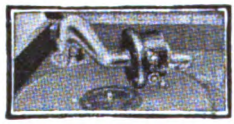
AMPLION

The World's Standard Loud Speaker


Rubber Bushing Insulating Wooden Horn from Metal Sound Conduit
Metal Sound Conduit Highly Finished
Rubber Bushing Insulating Sound Conduit from Reproducer
Nickel Plated Hinged Stand for Lowering or Elevating Horn
Screw for adjusting diaphragm to meet all conditions of Rec. Sets

Amplion Deagon AR-19
$40.00

Phonograph Unit AR-35
$24.00



Amplion Beauty AR-15
$46.00

Amplion Junior DeLuxe AR-45
$26.00

A few practical points about Amplion supremacy

The Amplion requires no power amplifier—no battery. You simply attach it to regular head phone connections.

The diaphragm is made of a special alloy, found to have no equal after years of experiment with all other materials.

The electro-acoustical device is insulated entirely from the horn to eliminate distortion, ring or resonance.

Its Non-vibrating wood horn surpasses all other materials for true tone and clearness.

An Adjustable feature makes the Amplion sound true with any make of receiving set, and ensures faithful reproduction.

The Amplion mechanism is not new—it has not been hurriedly devised to meet the radio boom. Rather, it is a development, for radio purposes, of a loud speaking device used for years by leading Navies of the world.

The Amplion is manufactured by the oldest manufacturer of loud speakers in the world.

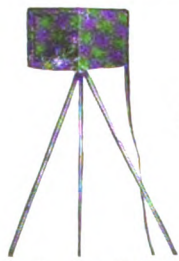
The Mahogany horn—the enameled sound conduit—the highly polished nickeled base—the reproducing mechanism—all are of the highest quality.

Ask your dealer for a demonstration.

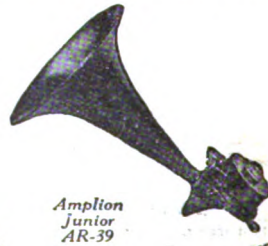
Patentees: ALFRED GRAHAM & CO.

SIGNAL ELECTRIC MFG. COMPANY
Sole United States Distributors — Menominee, Michigan

BURNDEPT OF CANADA, LTD.
Canadian Distributors — 172 King Street W., Toronto



Amplion Portable AR-61
$50.00



Amplion Junior AR-39
$18.00

The Supremacy of The Amplion is The Supremacy of Actual Performance

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The Improved MIRACO Gets 'em from Coast to Coast

Model K
(SHOWN ABOVE)
$29.50

It is a two-tube outfit consisting of one stage of tuned impedance radio-frequency amplification with a tuner and vacuum tube detector.
This radio-frequency receiver amplifies before it detects, eliminates interference to a marked degree and has much more volume than most one-tube sets.

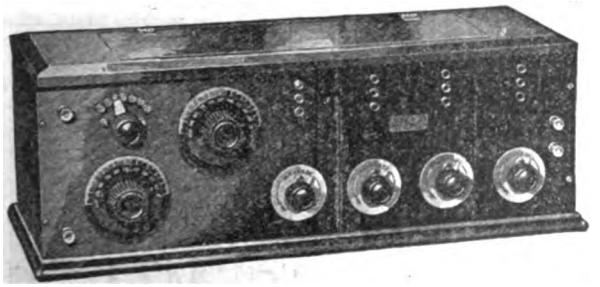
Model MW
(SHOWN BELOW)
$54.50

The Model MW consists of the same high-grade units as our Model K, with the addition of a two step audio-frequency amplifier in a single beautifully finished solid mahogany cabinet. It is a four-tube set, comprising one stage of tuned impedance radio-frequency amplification, detector and two stages of audio-frequency.

Just like the sweet, mellow tones of a flute or violin floating in from afar out on a lake—that's the way concerts come in through MIRACO receivers—and—
Not only from the nearby stations either. For our users tell us that Cincinnati hears 'Frisco, Denver hears Schenectady New York hears Havana! Scores of long-distance records were made on these instruments last year so, with the many new refinements incorporated, the results obtainable will be far better now than ever.

HIGHEST QUALITY AT LOWEST PRICE

When the radio craze swept the country like a storm late in 1921, MIRACO was one of the first real successful sets to be placed on the market. *Highest quality* at the *lowest price* has always been our keynote, and the thousands of sets now in use all over the world are a fitting tribute to Miraco's excellent performance. Many new improvements have just been made in the MIRACO Models K and MW, such as new sockets resting on shock absorbing pads is a refinement found only in the most expensive and elaborate sets. Improved rheostats with multiple resistance windings makes it possible to use any type of tubes and a new aluminum shield prevents annoying body capacity effects.
The cabinet is of solid mahogany, workmanship throughout is the finest while its operation is extremely simple yet always dependable.



Write for our new bulletin TODAY

DEALERS — JOBBERS
Write for proposition quickly.

AGENTS
There's still some territory open—write or wire.

THE MIDWEST RADIO CO., 812 MAIN STREET CINCINNATI, OHIO

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Impartial Experts Testify!

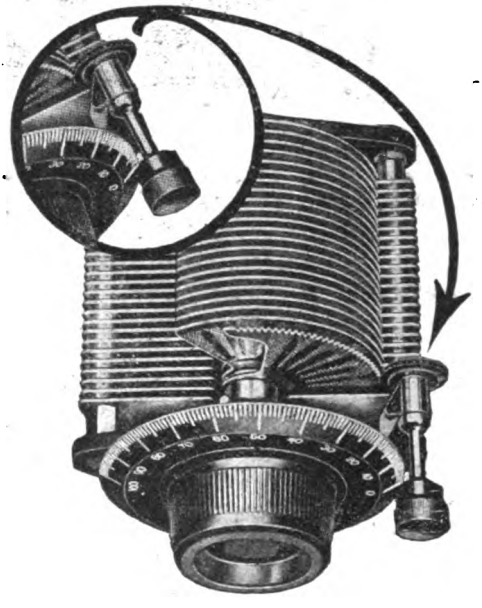
For a long time, set builders have wanted some definite, authoritative guide to condenser quality. Complying with this demand, HEATH RADIANT CONDENSERS were submitted to two of the greatest radio testing laboratories. Below are salient phrases from their reports. Copies of the complete reports free to anyone interested.

Electrical Testing Laboratories of New York, *Says*—

". . . the equivalent series resistance of each of the condensers is very small. That is, it is *so small* that it may be considered as *negligible.*"

Radio News Laboratories, *Says*—

". . . considered one of the best condensers we have tested. A dielectric loss resistance of 46 ohms at 1000 cycles."



HEATH RADIANT CONDENSERS

Permanently Flat Plates

Precise, when you examine it at the store, and, still more important, p-r-e-c-i-s-e *always,* for years — the most durable, continuously efficient part of your set. Warping plates made *impossible* by the *Heath* process of stamping and hardening which makes each one permanently FLAT PLATES.

Micrometer-Adjusting Geared Vernier

Reducing gear, engaging with teeth cut into the outer rim of the vernier plate, affords infinitely delicate adjustment. An added feature of satisfaction that makes it well worth your while insisting upon *Heath Radiant Condensers.*

Write for Booklet

List Prices **— Vernier Type (With 2⅞″ dial and knob)**
13 Plate, $5.00 25 Plate, $5.50 45 Plate, $6.50

HEATH RADIO & ELEC. MFG. CO.

204 First Street :: :: :: Newark, N. J.

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The New

MU-RAD RECEIVER

MA-15

THE HORIZON of the radio art extended and broadened by this new perfection of radio reception—the more versatile, more simply operated receiver, *Mu-Rad MA-15*. Many important refinements—plug-in type radio frequency transformers, so that the MA-15 can be accommodated to any future changes of wave lengths or tubes, volt-meter for instantaneous readings of "A" or "B" batteries, new type vernier dials, operated by cams to eliminate back-lash, no other aerial than a 2-foot loop needed, and a wave length switch for bringing in short wave stations. Solid mahogany cabinet, with an engraved Formica panel. The MA-15 anticipates every possible use and requirement. *Guaranteed range, 1,000 miles using 2-foot loop.*

Another New MU-RAD Receiver MA-17

Three stages of radio and two of audio frequency amplification and detector. *One* tuning dial and two selecting dials, each independent of the other. Plug-in type r. f. transformers to care for changes of tube type or wave lengths. Panel-mounted volt-meter for quick reading of A and B batteries. Solid mahogany, Adam Brown hand-rubbed finish cabinet with loop fitted into top and compartment in base for B batteries. Guaranteed for 1000 miles reception using only a 2-foot loop.

WRITE FOR BOOKLET AND NAME OF NEAREST DEALER

MU-RAD LABORATORIES, INC.
609 FIFTH AVE ASBURY PARK, NEW JERSEY

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DEALERS!

N. & K. Phones can be had at any time and in any quantity. We, as exclusive distributors for the United States and Canada, are always carrying in New York a large stock of these truly fine headsets in order to supply the demand promptly. N. & K. headsets are manufactured by Neufeldt & Kuhnke, Kiel, Germany — known the world over as leaders in their line.

We have a Profit Proposition to offer dealers. Write us for complete details.

Kindly address inquiries to Dept. C.

Th. Goldschmidt Corporation

15 William Street, N. Y. C.

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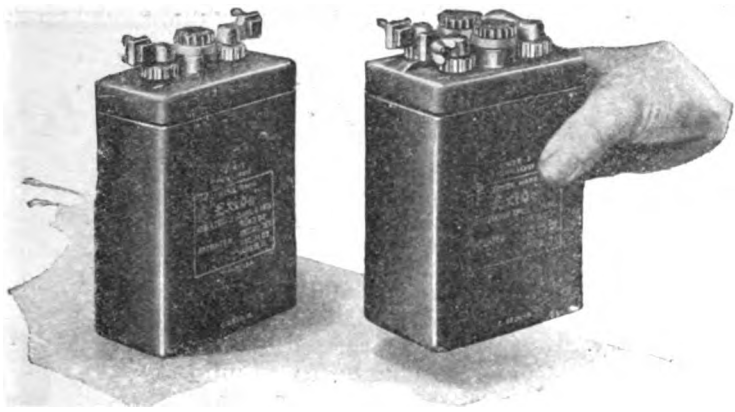

What you have been waiting for

HERE are two rugged little storage batteries designed particularly for low-voltage tubes.

Although they weigh only 5 and 6 pounds, they are of true Exide quality. Highly efficient and with ample power for long-distance receiving, these batteries will give you a type of service that you would find it hard to duplicate.

These sturdy little batteries are neat and compact. They were specially designed for WD-11 and UV-199 vacuum tubes, but can be used with any low-voltage tube. The two-volt Exide A Battery consists of a single cell. It will heat the filament of a WD-11 or other quarter-ampere tube for approximately 96 hours. The four-volt A Battery, having two cells, will light the filament of a UV-199 tube for 200 hours.

For six-volt tubes

Like all Exide Storage Batteries, the Exide A Battery for six-volt tubes is dependable and long-lasting. It is made in four sizes, of 25, 50, 100 and 150 ampere hour capacities.

As you know, any variation of current in the plate circuit produces weird sounds in your phones. With an Exide B Battery hooked up to your set, static is the only undesirable sound you will have to contend with. The Exide B Battery supplies steady, noiseless current. It permits the niceties of adjustment that make radio receiving an unalloyed pleasure.

The Exide A Battery for six-volt tubes has extra-heavy plates, assuring constant potential and uniform current over a long period of discharge. Like all Exide Batteries, it embodies the finest materials available.

Exide B Batteries

give noiseless, full-powered service over a long period of discharge. Designed throughout to prevent electrical leakage. Capacity, 3 ampere hours.

In marine and commercial wireless

On sea and on land the Exide plays an important role in the industrial life of the nation. In marine wireless, Exide Batteries provide an indispensable store of emergency current. A majority of all government and commercial wireless plants are equipped with Exides.

Exide Radio Batteries are sold by radio dealers and Exide Service Stations everywhere. Ask your dealer for booklets describing in detail the complete line of Exide Radio Batteries. Or write direct to us.

Exide
RADIO BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

Oldest and largest manufacturers in the world of storage batteries for every purpose

Service Stations Everywhere — **Branches in Seventeen Cities**

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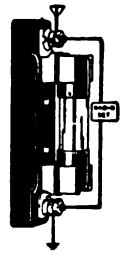
A Lightning Arrester—

Is Required by the 1923 National Electric Code

Our Lightning Arrester No. 606 provides means whereby the static electricity that collects on every antenna during certain atmospheric conditions may discharge to ground without injury to coils, condensers or other delicate apparatus.

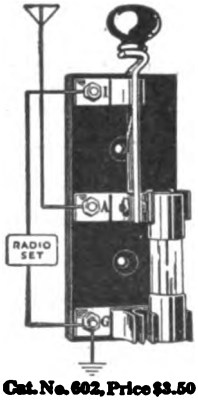
It is a Vacuum Tube Arrester of the highest workmanship and material, designed along lines that our experience has proven to be correct.

This Lightning Arrester is approved by the Underwriters Laboratories.



Cat. No. 606, Price $2.00

For Those — Who want the best



Cat. No. 602, Price $3.50

"For those who want the best" our Lightning Arrester Switch No. 602 has no competitor on the radio market.

The Vacuum Tube Arrester is always on the job ready to spill any overcharge. With the switch blade the antenna may be disconnected from your set and thrown directly on ground.

This device combines on one base the requirements and the added recommendations of the 1923 National Electrical Code. It is approved by the Underwriters Laboratories.

CHICAGO, ILL.
15 S. CLINTON ST.

BARKELEW

SAN FRANCISCO.
72 FREMONT ST.

ELECTRIC MANUFACTURING CO.
MIDDLETOWN, —— OHIO.

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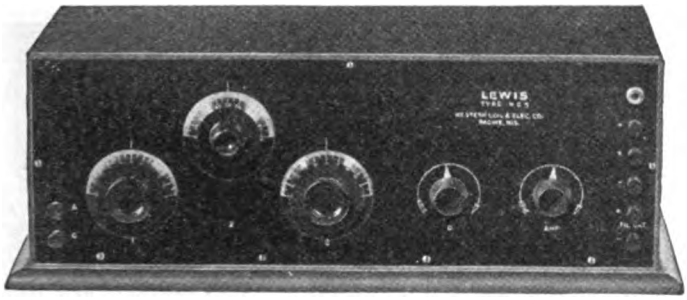

A Special Low Wave Set for Transmitting Amateurs

Does your receiving set respond readily to short wave signals? The WC-5-SW set shown above was designed by short wave specialists to help you. It picks up signals on wave lengths from 90 to 380 meters sharp and clear. The WC-5-SW has proven itself to be the most practical receiving set for low wave specialists.

WC-5-SW

Built Especially for Transmitting Amateurs

The WC-5-SW is a 4 tube set. One stage of tuned Radio Frequency amplification is employed ahead of the detector to make it supersensitive. Two stages of audio frequency are used to bring up the signal strength. Uses any type of tubes. Gives perfect control of audibility. Detector rectifies only. Uses antenna compensating condenser. Only two control adjustments. Pure negative biasing on all tubes, thus marked saving on B Battery current. Tuned Radio Frequency sharpest known and most selective principle ever adopted. Plate potential non-critical. Mono-block tube socket. No grid plate leads on audio amplifiers. Audio amplification absolutely necessary when using low efficiency receiving antenna, i.e., underground or indoor. Mahogany cabinet, piano rub finish. Rabbited-in panel. Split lid cover. The price is $85.00.

Write for complete description and illustrated folder on this practical set for low wave specialists. All transmitting amateurs will be interested in this literature.

OTT RADIO, Inc.

222 Main Street **La Crosse, Wis.**

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SOLID COMFORT

Comes With The Use Of The

TRADE MARK
AUDIOPHONE
REG. U. S. PAT. OFFICE

because nothing is lost from the original broadcasting

Not only is it easily possible to distinguish the words of the speaker, but also the minute graduations in pitch, timbre and quality of overtones which distinguish individual voices.

The Audiophone is complete and self-contained—needs no separate battery or other accessories—goes to you ready for use on connecting to your receiving set. It will prove a source of lasting pride and pleasure.

Audiophone Sr.....Price $32.50
Audiophone Jr.....Price 22.50

BRISTOL ONE STAGE POWER AMPLIFIER

If greater volume is desired, over what you already obtain, use the Bristol One Stage Power Amplifier. No C Battery required
Price $25.00

THE BRISTOL COMPANY
WATERBURY, CONN.

THE BRISTOL COMPANY
Waterbury, Conn.

Please send me without cost or obligation to myself, Bulletins Nos. 3006 and 3011-L on Bristol Audiophone and One Stage Power Amplifier.

Name.....

Street and No.....

City.....State.....

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ZENITH

Licensed under Armstrong U. S. Patent No. 1,113,149

AT THE NORTH POLE

INSIDE the Arctic Circle, nine degrees from the North Pole, a little 89-foot schooner is frozen fast in the ice of Smith Sound. Aboard this schooner a group of brave men are enduring, as best they can, the desperate cold of the Arctic—cold that often drops to 60 degrees below zero. Human atoms in a boundless field of ice!

Cold is hard to endure, but far more terrible is the Arctic solitude—unbelievably oppressive. Radio, at length, has broken this spell forever!

Concerts from Honolulu!

Daily, by means of powerful sending and receiving apparatus, the crew of the "Bowdoin" are in communication with relatives and friends in the far-off States. Daily they listen to concerts as far away as Chicago, Dallas and Honolulu!

When the sanity, the very lives of one's shipmates may depend upon contact with the outside world, none but the BEST is good enough.

Dr. MacMillan's Choice—the Zenith

Out of all the radio sets on the market, Dr. MacMillan selected the Zenith exclusively—because of its flawless construction, its unusual selectivity, its dependability and its tremendous REACH.

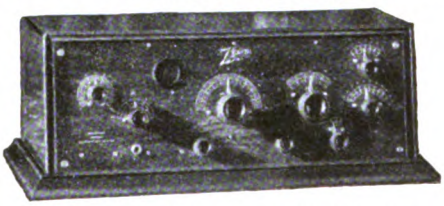
Already his operator, on board the "Bowdoin" IN NORTHERN GREENLAND, has tuned in several hundred stations. You along the Atlantic who brag a little when you tune in Catalina Island—what would you say if you tuned in Hawaii FROM THE ARCTIC CIRCLE?

The set that Dr. MacMillan has is a standard Zenith receiving set. And you can do all that MacMillan does, and more, with either of the two new models shown at the right. Their moderate price brings them easily within your reach. Write today for full particulars.

Zenith Radio Corporation
McCormick Building, Chicago

MODEL 4R—The new Zenith 4R "Long-Distance" Receiver-Amplifier comprises a complete three-circuit regenerative receiver of the feed-back type. It employs the Zenith regenerative circuit in combination with an AUDION DETECTOR and THREE-STAGE audio-frequency amplifier, all in one cabinet.

The Zenith 4R may be connected directly to any loud-speaker WITHOUT the use of other amplification for full phonograph volume, and reception may be satisfactorily accomplished over distances of more than 2,000 miles..... **$85**



MODEL 3R—The new Zenith 3R "Long-Distance" Receiver-Amplifier combines a specially designed distortionless three-stage amplifier with the super-efficient Zenith three-circuit regenerative tuner.

Fine vernier adjustments—in connection with the unique Zenith aperiodic or non-resonant "selector" primary circuit—make possible extreme selectivity.

2,000 to 3,000 Miles with Any Loud-Speaker

With the new Zenith 3R satisfactory reception over distances of 2,000 to 3,000 miles and over, is readily accomplished in full volume, using ANY ORDINARY LOUD-SPEAKER. No special skill is required. The Model 3R is compact, graceful in line, and built in a highly finished mahogany cabinet..... $160

ZENITH RADIO CORPORATION,
Dept. C. 328 South Michigan Ave., Chicago, Ill.
Gentlemen:—
Please send me illustrated literature on Zenith Radio.

Name .....

Address .....

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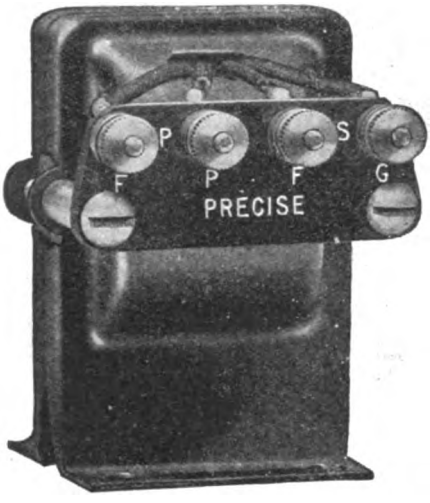
By Merit Alone,



Model 285A—$5.75

Precise Audio Transformers are the choice of those who discriminate.

The 4½ to 1 ratio yields the highest degree of amplification without distortion, and the deeper tones so often lost find their place in the wonderfully realistic recreation of broadcasted music. Recommended for neutrodyne circuits.

Our voltage amplification test chart No. 1094 is convincing of the remarkable performance of this transformer.

Write today for this chart and illustrated circular describing our VERNIER RHEOSTAT and SWITCH LEVER.

Trial Offer

If your dealer cannot furnish these, send us his name or on receipt of price we will forward you any instrument for ten days trial and will refund your money on return if unsatisfactory.

PRECISE MANUFACTURING CORPORATION

Rochester, :: :: :: New York

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53 W. Jackson Blvd. Chicago, Ill. — **821 Market Street San Francisco, Cal.**

Distributed in Canada by Perkins Electric, Ltd.

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Clear as a Silver Bell

The O-T is the only genuine Silvertone Tube. Fully guaranteed. Beware of imitations.

O-T SILVERTONE TUBES

(Registered)

In your radio set assure—

sharp, clear, mellow tones—
music with its delightful and thrilling modulations—
speeches without distortion, audible down to a whisper—
and all the other joys of Radio at their best

Three Models

O. T. 1A—2 to 4 volts, Battery Draw .15 amps. Price, $6.00

O. T. 9—2 to 4 volts, Battery Draw .06 amps. Price, $6.50

O. T. Power Tube—5 volts, Battery Draw .25 to .35 amps. Price, $7.50

At your dealer or direct by mail. Write for complete literature.

Manufactured by DeForest Tel. & Tel. Co.

Exclusively for the

O. & T. Electric Corporation

1819 Broadway, New York

High class representatives wanted.

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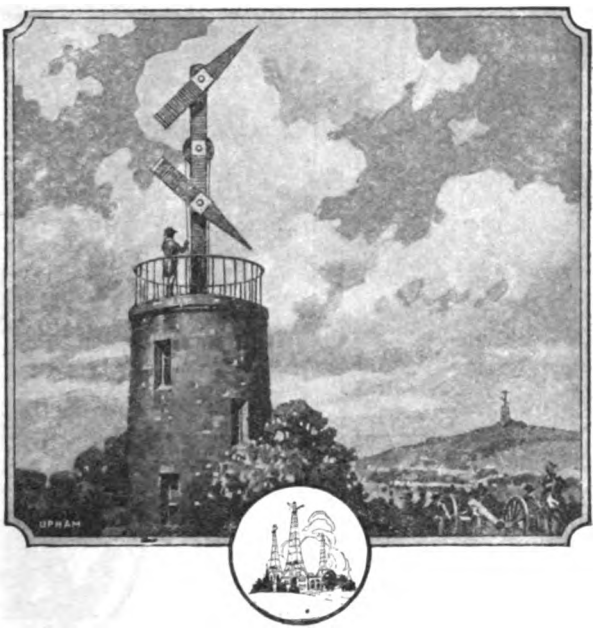

IN NAPOLEON'S DAY

IN the early part of the nineteenth century the semaphore was the quickest means of transmitting information. Great battles often hinged on the information received or sent by this method.

Today, due to sensitive instruments and electricity, messages are conveyed over vast distances with the speed of light.

Your radio set receives the faint electric waves sent through space and builds them up into relatively strong currents, but it is your head phones that transform this current into the music or spoken words that you hear.

Your set can be no better than your head phones and, as the enjoyment of broadcasting depends upon the quality of sound, you cannot be satisfied with inferior phones.

Holtzer-Cabot Phones are the perfected results of over twenty-five years specialization in sensitive electrical instruments. With Holtzer-Cabot Head Sets you may be sure that you are getting all the enjoyment that your radio set can give.

Holtzer-Cabot Loud Speaker, $25.00
Holtzer-Cabot Phonograph attachment, 10.00
No. 2 Universal Head Phones, 9.50
No. 4 National Head Phones, 6.00

Write for booklets, "What You Should Know About Radio Reception" and "A Better Loud Speaker."

THE HOLTZER-CABOT ELECTRIC CO.
125 Amory Street, Boston, Mass.
6161-65 South State Street, Chicago, Ill.
Department B

Holtzer-Cabot
BUSINESS ESTABLISHED 1875

HEAD SETS

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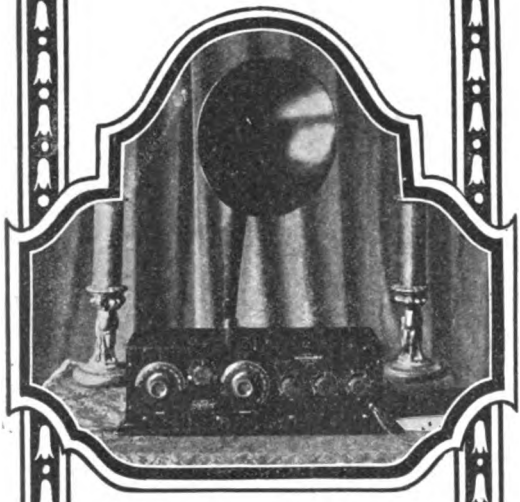

ANYONE CAN OPERATE THE

RADIODYNE

"The Voice of the Nation"

You don't have to be an expert to install and operate the RADIODYNE effectively. It is operated by simply grounding to a water pipe or radiator and throwing a few feet of wire on the floor.

For use in apartments, boats, automobiles, railroad trains, etc., the RADIODYNE is enjoyable where other types of receiving sets would not be practical.

Stations within a radius of 2000 miles can be picked up on the loud speaker; any wavelength from 200 to 700 meters. The RADIODYNE is so sensitive that it picks up Radio telephone speech and music when other types of equipment fail.

Write for illustrated folder which describes the RADIODYNE in detail. Every radio fan will be interested in this new type (antennaless) receiving set.

WESTERN COIL & ELECTRICAL CO.
308 5th St., :: Racine, Wisconsin

The E. J. Flewelling Condenser

Extra rugged construction—plates heavy enough to eliminate all possibility of misalignment made the Flewelling Condenser one of the acknowledged hits of the Chicago Radio Show.

Its careful electrical and mechanical design places it among the few really efficient instruments.

All Flewelling parts maintain this high standard and are the latest and most up-to-the-minute designs of modern Radio.

Twenty-three Plate .0005 $8.00

Flewelling Tuners $8.00

Flewelling Sockets $1.00

Eleven Plate .00025

$6.00 At Your Dealer's or Postpaid

BUELL MANUFACTURING COMPANY
2977 Cottage Grove Avenue
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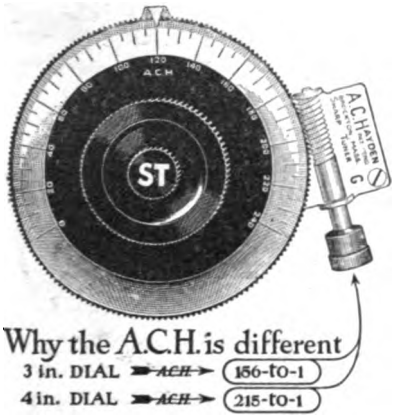
A PLEASANT SURPRISE

Awaits the User of the

A. C. H. SHARP TUNER DIALS



ROUGH TUNING OR 1,000 OF AN INCH IN EITHER DIRECTION

CAN BE INSTALLED AND WILL IMPROVE ANY RECEIVING SET MAKING DIFFICULT TUNING EASY

Price 3 inch size.....$2.50 complete
Price 4 inch size.....$5.00 complete
Regular fitting 5/16 shaft 1/4 and 3/16, 5 cts. each, extra

Money Back Guarantee

The principal of the A. C. H. Sharp Tuner has only been embodied on very expensive instruments where the most delicate adjustment is necessary and then as a permanent part.

Extra Advantage of the A. C. H.

1. Can be attached or removed from any instrument.
2. Rough tuning same as any dial.
3. Movement so fine that the eye cannot detect but the ear can.
4. Automatically locks instrument so no jar can disturb it.
5. Dial grounded reducing body capacity to a minimum.
6. Special dial 2 graduations where ordinarily one.

Mail orders sent prepaid in U. S. A.

A. C. HAYDEN RADIO & RESEARCH CO.

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SOLD BY RADIO LTD., MONTREAL, CANADA

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"RESIST-O-METER Means Perfect Resistance Control"

TYPE-2A

PERFECT ELECTRIC CONTROL
RESIST-O-METER
TRADE MARK

Ideal Filament Control Over All Receiving Tubes

(Also 5 Watt Power Tubes)

RANGE 0—60 OHMS

Complete vernier action over entire range.

Non-packing fibrous cushion type of resistance variation.

Positively silent in operation.

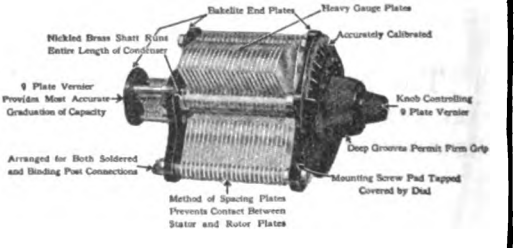
Size back of panel, 1⅛", diameter 2⅜".

PRICE $1.80

SCHOLES RADIO & MFG. CORP., 32 W. 18th St., N.Y.

The New CHELTEN RADIOSCOPE Condensers

Produce results not possible with ordinary type condensers. The 9 plate VERNIER feature is far more selective than the single or any multiplication of larger plates. THE RADIOSCOPE is made in 45 and 23 plate type. It is extremely accurate and tunes sharply. See accompanying illustration.


Bakelite End Plates
Heavy Gauge Plates
Nickled Brass Shaft Runs Entire Length of Condenser
Accurately Calibrated
9 Plate Vernier Provides Most Accurate Graduation of Capacity
Knob Controlling 9 Plate Vernier
Deep Grooves Permit Firm Grip
Arranged for Both Soldered and Binding Post Connections
Mounting Screw Pad Tapped Covered by Dial
Method of Spacing Plates Prevents Contact Between Stator and Rotor Plates

The CHELTEN SPECIAL CONDENSER

Carefully designed for high oscillating RADIO FREQUENCY Circuits. We have developed a Special High Resistance Insulation which is used between the rotor and stator plates to prevent leakage of Radio Frequency Currents. This Special Insulation shows lower losses than any of the Phenol Insulating materials now on the market. Made in 45 and 23 plate type with and without Vernier.

THE CHELTEN MIDGET
Vernier Condenser

Ideal for use with any Variable Condenser as a Vernier. Has 13 plates which permits of finer graduation of Capacity than is possible with a single plate Vernier. Can be used to advantage in many circuits. Price is only $1.50.

CHELTEN MICROFARAD JR.
Low Capacity Condenser

A special Neutralizing Condenser of extremely low capacity having only 9 plates. Adjustments are made by a turn of the knob. No body capacity when making adjustments. The most satisfactory Neutralizing Condenser made. Price $1.75.

Send for Catalogue of Chelten Radio Products

THE CHELTEN ELECTRIC COMPANY

4861 Stenton Avenue, Philadelphia

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In an easy chair at home MAGNAVOX *gives you the melody of concert and opera*

MAGNAVOX
Radio
Reproducers and Amplifiers

THE secret of the marvelous results obtained with Magnavox Reproducers does not lie in any *one* feature (such as the shape or material of the horn) but in the correct working out, in *all* features, of correct scientific principles.

Magnavox Reproducer

R2 with 18-inch curvex horn $60.00

R3 with 14-inch curvex horn $35.00

M1 with 14-inch curvex horn. Requires no battery for the field $35.00

Magnavox Combination Sets

A1-R consisting of electro-dynamic Reproducer with 14-in. curvex horn and 1 stage of amplification . $59.00

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A1—1-stage . . . $27.50

AC-2-C—2-stage . $55.00

AC-3-C—3-stage . $75.00

Magnavox Products are for sale at Registered Magnavox Dealers everywhere. Write for new 32-page Magnavox Radio Catalogue.

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New York Office: 370 Seventh Avenue

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For every Receiving Set there is a MAGNAVOX

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Biggest dollar's worth in RADIO

JUST OUT

Compiled by
HARRY F. DART, B.S.E.E.
Formerly with the Western Electric Co., and U.S. Army Instructor of Radio
Technically edited by
F. H. DOANE

THE greatest book on Radio ever written. Price only $1. Filled with sound, practical, tested information for every radio fan, from beginner to hard-boiled owl. Written, compiled and edited by radio experts of national reputation.

You may dip into this I. C. S. Radio Handbook at random, or hunt up special information you want, or read it right through. Starts with simple explanations of Radio phenomena and leads you along gently until you can understand the most technical diagram. Hundreds of suggestions for getting more pleasure out of Radio. Will save you from wasting money on things that won't work.

New—Authoritative—Complete

514 PAGES
150 ILLUSTRATIONS

Every page tells you something useful. And there are 514 pages! More than 150 illustrations and diagrams! Note this partial list of contents:

Different types of receiving and sending hookups, electrical terms, condensers, oscillating circuits, coupled circuits, induction coils, antenna systems, electric batteries, generators and motors, protective devices, crystal detectors, arc generators, transmitters, filters, wavemeters, radio experiments, International and Morse codes, commercial receiving sets, tables and data, radio transmitting and broadcasting stations (with call letters), Radio License Regulations, etc.

Send $1 to-day and get this 514-page I. C. S. Radio Handbook before you spend another cent on parts. Money back if not satisfied.

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I enclose One Dollar. Please send me—postpaid—the 514-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

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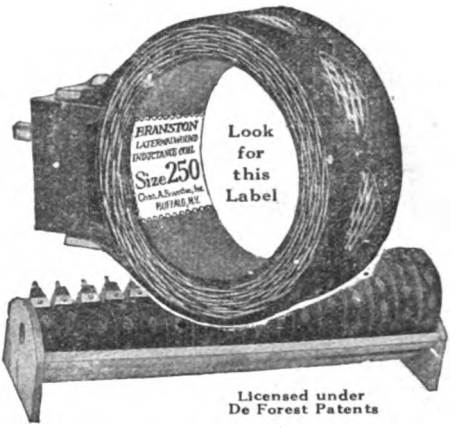
BRANSTON RADIO



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De Forest Patents

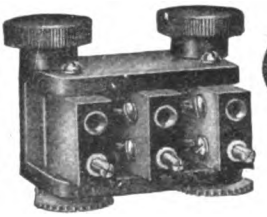
Select the coil combination for the wave lengths you want

Sixteen sizes to choose from

Using Branston D.L.Lateral Wound Honeycomb Inductance Coils you can choose the two or three coil combination that will give you the field of wave lengths in which you wish to operate. Branston Coils are interchangeable with all coil mountings, wave lengths from 150 to 21,000 meters.

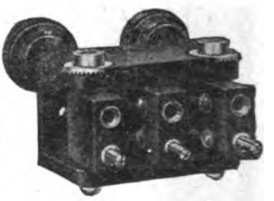
Branston New Front and Rear Panel Honeycomb Coil Mountings Are Better

Note the simple, sturdy, substantial, front and back panel three coil mountings, illustrated below. We show but two of a complete line of two and three coil mountings.



R-61 Three Coil Geared Type. Front Panel Mounting. **$5.00**

Substantial gears give vernier adjustment. Very neat appearance; made of Genuine Bakelite, complete with flexible leads.



R-62 Three Coil Bevel Geared Type. Back Panel Mounting. **$6.00**

Bevel gears provide very smooth operation and vernier adjustment. Made of Genuine Bakelite, complete with flexible leads. Arrow knobs show position of coils.

Look for this trade-mark card in your dealer's window or salesroom

Send 2c Stamp for New Honeycomb Coil Hookups

Compiled by experts and includes five good Honeycomb Coil "Hookups" and complete catalog of famous Branston Radio Apparatus. Write today. Give us name of your radio dealer. If he cannot supply you, write

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Manufacturers of Branston Violet Ray High Frequency Generators
811 Main St., Buffalo, N. Y.
In Canada—Chas. A. Branston, Ltd., Toronto

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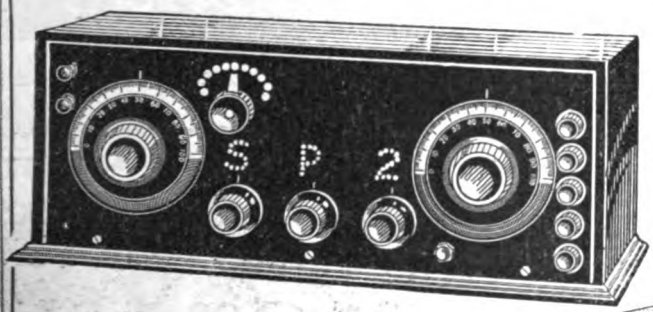
Oversold!

As this page is written (November 19th) the SP2 RECEIVER is OVERSOLD till after Christmas.

The Receiver that *sells*—the most remarkable *merchandising* set on the market.

In a Chicago store, over 300 SP2 Receivers sold in *one* day; 2000 sold in less than two weeks in one store.

You are not in the Radio business till you handle the SP2. Demonstration invariably inspires sale. Makes wonderfully satisfied customers. Builds business. Quick sales—big volume—satisfactory profit.



The S-P-2 RECEIVER
Radio's most phenomenal success!

Write Today for Catalog No. 101A

Pittsburgh Radio Supply House

963 Liberty Avenue Pittsburgh, Pa.

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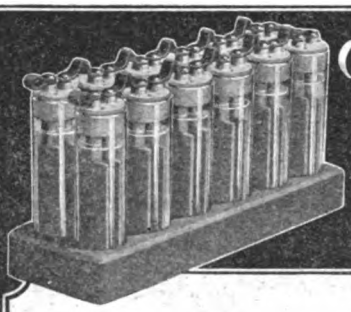

The RāBAT
a Rechargeable Wet 'B' Battery at Only $3.96

A rechargeable wet "B" Radio battery built strictly on storage battery principles. Yet it costs only a trifle more than an ordinary dry cell battery.

The Rabat at the low price of $3.96 has 12 cells with a total of 24 volts and ample capacity. It is noiseless, fool-proof, and compactly constructed. Built on a solid rubber base. Small, but neat and efficient. All elements visible. No internal discharge. More economical. Longer life. Higher and more continuous voltage. Easily recharged at home with aid of inexpensive Rabat Rectifier. If your dealer cannot supply you send direct.

Rabat Rectifier for Recharging $ .75

THE RADIO RABAT COMPANY

300 RUSSELL BUILDING Playhouse Square CLEVELAND, O.

12 CELLS The RāBAT 24 VOLTS

$25.00 for $10.00
Loud Speaker Direct

Cut out all dealers' and middlemen's profits—this marvelous Loud Speaker comes direct from factory to your door.

Prepaid $10.00 Delivered to Your Door

You are saving three profits, manufacturer to distributor, distributor to jobber, jobber to dealer.

The outstanding features of the Bel-Canto Loud Speaker are:—

1. Unbreakable fiber horn, crystaline finish.
2. Our own adjustable loud speaking unit giving a wide range of tone quality and volume without distortion.
3. Base of cast iron weighing 4 pounds eliminates top heaviness.
4. All other metal parts cast aluminum, highly polished.
5. Complete instruments stand 24" high, 10" bell.

Guaranteed one year from date of purchase against mechanical defects of any kind and if found mechanically defective within that period of time we will replace it with a new one without charge to you.

We further guarantee to the publication carrying this advertisement that each and every Speaker sold will be exactly as advertised in this issue.

$25.00 for $10.00

One complete Loud Speaker as described above sent on receipt of post office money order or sent C.O.D. delivered to your door. Give the postman $10.00 after you have received it.

BEL-CANTO MANUFACTURING COMPANY
Bensel-Bonis Company, Inc.

General Office and Factory: 417-419-421 East 34th Street, New York City

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Save 1/3 on Guaranteed Radio Equipment

Write us a post card—

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and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete tube set having a range of 500 miles and more, including tube, head set, batteries, and antenna equipment, as low as $23.50.

This catalogue contains everything for the expert and amateur. Complete sets and every improved part for building sets, all the most up-to-date devices—at the lowest possible prices.

Headquarters for Radio

Montgomery Ward & Co. is headquarters for Radio, selling everything direct by mail without the usual "Radio-profits." Why pay higher prices? Ward quality is the best and the prices will often save you one-third. Everything sold under our Fifty Year Old Guarantee—Your Money Back if You Are Not Satisfied. Write today for your copy of this complete 52-page Radio Book.

Write to our house nearest you
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Established 1872

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The Oldest Mail Order House is Today the Most Progressive

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Rely on De Forest Audions

WHEN you wonder what vacuum tube will work best in your radio set, find out who invented the 3-electrode tube as used in all present day radio. The answer—like the answer to most radio questions—is De Forest.

RADIO CATALOGS FREE

Send us your name and address and we will send you the new De Forest Catalog with full details and prices on sets, audions, and parts. Prices plus approximately 6% for territories west of the Rockies.

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Western Sales Division
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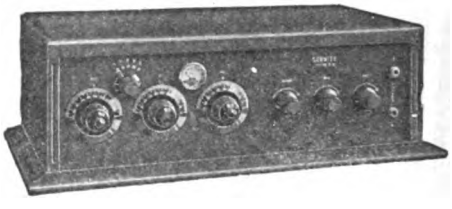
DE FOREST

SERVICE ABOVE ALL
SERVICE RADIO CO.

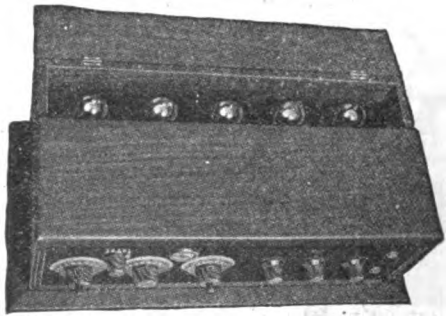
The "Radio Magnet"

which will attract desired programmes and eliminate undesired signals, etc., is known as Service Type 212 Receiver. Greatest distance, clarity and freedom from unwanted "noises."

"Hearing" is believing. **Ask your dealer for a demonstration.**



Price $150 With Loop Antenna



This is a TELEFORCE product

SERVICE RADIO CO.

4745 Montgomery Ave.
NORWOOD, OHIO

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—delight him with a distance-getting

ALL-AMERICAN

The Largest Selling

AMPLIFYING TRANSFORMER

Audio Frequency ***Radio Frequency***

Without distortion, "All-Americans" bring in distant and nearby stations with volume and tone-quality that mean real thrills. The best known and most widely used transformers on the market. Over 300,000 in use. All the "old-timers" are for the "All-American." Standard equipment on the better sets. They give unequalled results in *all* circuits.

All better dealers sell "All-American."

RAULAND MFG. CO.
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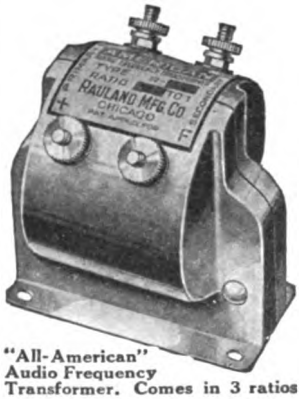
CHICAGO
Pioneers in the Industry

Special Free Offer

Book of tested hook-ups for getting new thrills out of your present radio outfit. Enclose 2 cent stamp for postage.



"All-American" Audio Frequency Transformer. Comes in 3 ratios

ALL-AMERICAN

Largest Selling Transformers in the World

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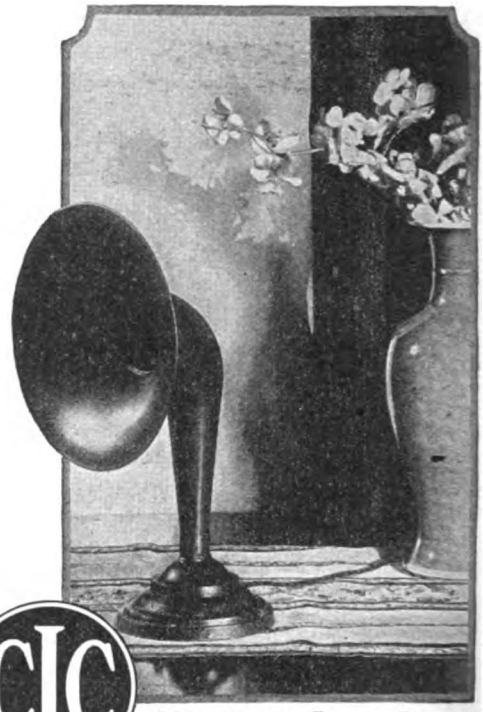
Remember

the letters "C. I. C." when you buy a loud speaker or a phonograph attachment. You will never forget your satisfaction.

The C. I. C. Loud Speaker is small in size and small in price —but great in tone quality and volume.

The C. I. C. loud speaking unit and phonograph attachment has a mica diaphragm and an adjustable air gap —it fits the standard makes of phonographs and can be used on any horn.

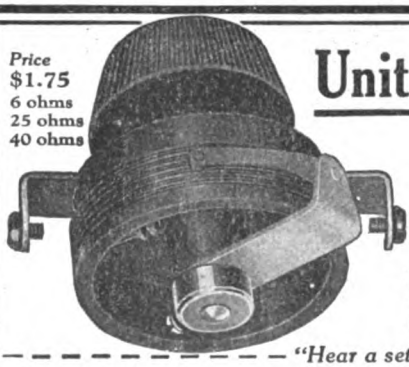


Send for Leaflet "Loud Speaker Facts"

Connecticut Instrument Co.
Stamford, Conn.

CIC

$14.50 Loud Speaker



Price
$1.75
6 ohms
25 ohms
40 ohms

Unity Rheostats are the Best

Vernier and Non-Vernier

The Unity Vernier Rheostat

(Successor to The Jenkins Rheostat)

Recommended for the detector tube of Cockaday four circuit tuner.

The highest type electrical instrument made for controlling resistance.

A refinement in tuning adjustment, far surpassing the possibilities of any other instrument, is very easily obtained.

The Unity Vernier Rheostat is the only Rheostat with a cut-out switch operating with no change in tuning adjustment.

— — — — — — — — — — *"Hear a set that uses Unity Rheostats"* — —

The Unity Non-Vernier Rheostat

or the Cartridge Rheostat

6 ohms
25 ohms
40 ohms

Other resistances if desired

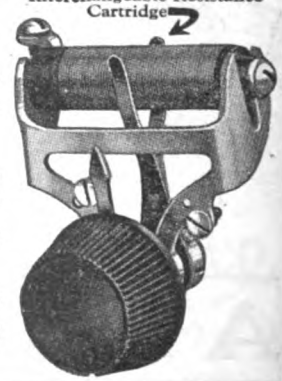
Where a non-vernier rheostat is sufficient, the Unity Cartridge Rheostat is the best made.

In addition, resistance cartridges are interchangeable without removing the bracket from the panel.

Unity Potentiometer Cartridges also fit the Unity Brackets

Complete Rheostats - - $ .80
Brackets only .45
Cartridges, any resistance - .35
Potentiometers, complete, 200 or 400 ohms 1.45
Potentiometer cartridges only 1.00

Interchangeable Resistance Cartridge



If your dealer cannot supply you, send your check or money-order to the factory with dealer's name.

UNITY MFG. CO., 228 North Halsted St., Chicago

Automatic Screw Machine Products, Stampings, General Manufacturing on Contract or Royalty.

Dealers are offered a free Counter Display Card.

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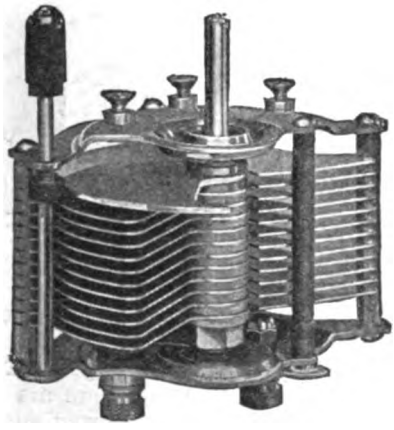
A Standard of Condenser Excellence
—note the points of proven Superiority!!

5 POINTS

1. Stator plates pressed into slots, assuring perfect electrical contact.
2. Proper capacities, and no over-rating of same.
3. Rigid construction, so original adjustment is maintained.
4. Rotor and stator plates of logarithmic curve type.
5. Formica insulation throughout.



5 MORE!

1. Patented vernier arrangement, eliminating body capacity.
2. Special spring aluminum plates.
3. Lowest dielectric losses, proven by laboratory tests.
4. Special friction bearing on rotor shaft.
5. Independent vernier control. Vernier does not rotate with main rotor plates.

A radio receiving set is no better than its variable condensers!

STRAITLINE
TRADE MARK

V A R I A B L E
VERNIER CONDENSER

Upon the condensers used depends the efficiency of your set. Buy only the best! You can pay a higher price—but cannot get a better condenser than STRAITLINE

Type G 13 Pl. .0002 mfd. **3.00** Type H, 23 Pl. .0005 mfd. **3.50** Type J, 43 Pl. .001 mfd. **4.00**

A Product of **HAIG & HAIG** Manufacturing Co.
ROCHESTER, NEW YORK

If your dealer has none send his name with your remittance direct to

RADIO STORES CORPORATION
Sole International Distributors

NEW YORK—CHICAGO—MINNEAPOLIS—LOS ANGELES—
CLEVELAND — ST. LOUIS — OMAHA — SAN FRANCISCO.
HOME OFFICE, 220 West 34th Street, NEW YORK, N. Y.

—insist on STRAITLINE

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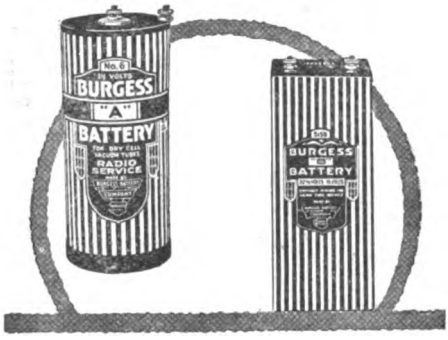
Burgess "A" Battery Introduces a New Silent Partner



Notice that—

He's exactly my size—same height—same width—same weight. We look like twins. (He's good looking, too.) Look us over.

Burgess is a big family. I have a lot of brothers. Perhaps the most famous of them is BIG BROTHER "B." He had the field to himself until Burgess introduced Vertical "B."

Now comes my new partner. He is VERTICAL "B" JUNIOR. He has the same 22½ volts of pep as the rest of the Burgess "B" family. He is quiet — never talks to himself and he never lays down on the job.

Burgess calls us "Work-mates." He ought to know. We are silent partners in your radio entertainment.

Your radio set is no better than your batteries. Without them would be like having a marriage license and no bride. One is *no* good without the other.

Try it tonight. I'll heat your tube filament while my twin partner takes care of the plate circuit.

A Laboratory Product

BURGESS BATTERIES

"ASK ANY RADIO ENGINEER"

BURGESS BATTERY COMPANY

ENGINEERS - DRY BATTERIES - MANUFACTURERS
FLASHLIGHT - RADIO - IGNITION - TELEPHONE

GENERAL SALES OFFICE: HARRIS TRUST BLDG., CHICAGO
LABORATORIES AND WORKS: MADISON, WISCONSIN

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NEW YORK · BOSTON · KANSAS CITY · MINNEAPOLIS
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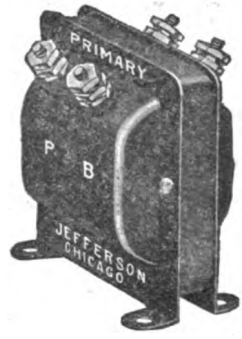
IN CANADA

PLANTS: NIAGARA FALLS AND WINNIPEG
BRANCHES: TORONTO · MONTREAL · ST. JOHN

The Final Authority in

RADIO FREQUENCY



The New Jefferson Radio Frequency Amplifiers need very little introduction. The name JEFFERSON is known wherever transformers are used. Both professional and amateur radioists are familiar with JEFFERSON Audio Frequency Transformers. They know from actual tests how superior they are to others and they have been waiting for a JEFFERSON Radio Frequency Transformer.

After many months of research and almost endless tests and experiments JEFFERSON Radio Frequency amplifiers have been pronounced by leading radio engineers to represent the very last word in this type of amplifier.

These new transformers cover the entire new wave length band (200 to 650 meters) and function with equal efficiency in standard Radio Frequency, Reflex, Inverse, Duplex or Neutrodyne circuits. Their scientific and careful construction sets a new standard for radio frequency amplification—the reasonable price appeals to all.

No. 80 Jefferson Radio Frequency Transformer (1st stage) . . . $2.50
No. 85 Jefferson Radio Frequency Transformer (2d stage) $2.50

Descriptive bulletins, circuits and the recommendations of our Radio Engineering Department are at your disposal.

Jefferson Electric Mfg. Co.

427 South Green Street, Chicago, Ill.

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The Golden Rule Tube

The discovery of the principle upon which the Sodion Tube was developed marks a new and better Era in Radio.
The tube itself is different from any you have ever known.
Different in principle—different in operation and different in results.
As its name implies, it makes such effective use of the peculiar properties of the sodium ion that there is no need of regeneration to build up the strength of your reception.
The fact that it does not oscillate not only eliminates all semblance of whistles and howls in your own reception, but makes it impossible for you to interfere with the reception of others.
It is the practical application of the Golden Rule to Radio.
Crystal tone reception.
Unusually sensitive to weak signals.
Stable and uniform in operation.
Runs for hours without adjustment.
Operates on dry cells or storage battery.

Bulletin A-100 upon request

CONNECTICUT TELEPHONE & ELECTRIC COMPANY
MERIDEN Radio Division CONNECTICUT

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Robert J. Casey (Chicago Daily News) —builds set of R P M Units

"The set is a two-tube regenerative double-jointed reflex *designed by the engineers of the Radio Products Mfg. Co.,*" writes Mr. Casey in Chicago Daily News, Nov. 3rd. In action it is a distinct surprise. Both tubes give a R.F. amplification stronger than many other circuits. Tuning sharp enough for anybody . . . One of the novelties of this hook-up is the *standardization* of *parts,* permitting easy change of the component elements.

"Another is the variable condenser which affords a micrometer adjustment with a variation from minimum to maximum that will do the work of any 1 to 43 plate condenser."

RPM

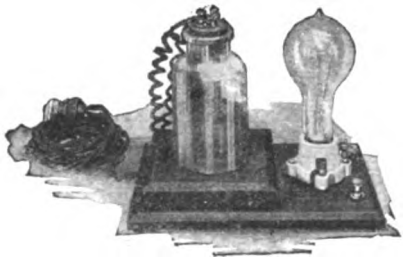
A UNIT FOR EVERY RECEIVING PURPOSE. MOUNTED AND UNMOUNTED VARIOMETERS, VARIOCOUPLERS, VARIABLE CONDENSERS, COUPLED CIRCUIT TUNERS. ALSO DETECTOR AND AMPLIFYING UNITS.

At a big saving, you can build this—or any other set—using R P M Standardized Units. *Hook-ups in every package.* No soldering of joints, no tools necessary. Merely connect binding posts. Each R P M Unit is complete in itself. Moulded Bakelite—very handsome, R P M units are efficient in performance, superior in quality and *have absolutely no body capacity.* You can pay more but you can't buy better units. At your dealers' or write us.

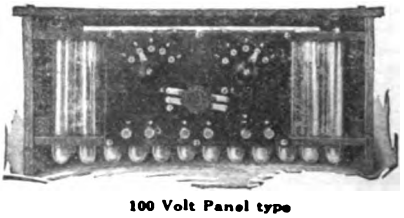
Unconditional Guarantee

RADIO PRODUCTS MFG. CO.

667 W. 14th St., Chicago



Mounted Charger



100 Volt Panel type

Trinidad Government Pleased with KIC-O Efficiency

"We are ordering this battery on behalf of the Trinidad Government whose wireless officer was impressed with the efficiency of the Kic-o battery we are using with our receiving set." The above extract is only one of the many endorsements we are receiving of Kic-o Batteries. Alkaline type, won't sulphate or buckle. Life unlimited. Not harmed by short circuiting, over-charging, or idleness. Panel switches give single cell variations. Recharge from any 110-volt A. C. line with small home rectifier. Charge lasts 3 to 6 months on 3 tube receiver.

GUARANTEE

Your money back on any KIC-O Battery if not satisfied within 30 days' trial. Write for full information on "A" and "B" Batteries.

Unmounted Rectifier.....**$1.00**

Mounted Rectifier.....**$2.50**

Cells	Volts	Price, Plain	With Panels
16	22	$5.50	
24	32	7.25	$11.75
36	48	9.50	14.00
50	68	12.50	17.00
78	100	17.50	22.50
108	145	23.50	28.50

KIMLEY ELECTRIC COMPANY, Inc.

2667 Main Street **Buffalo, N. Y.**

KIC-O **Storage "B" Batteries— long service, low cost**

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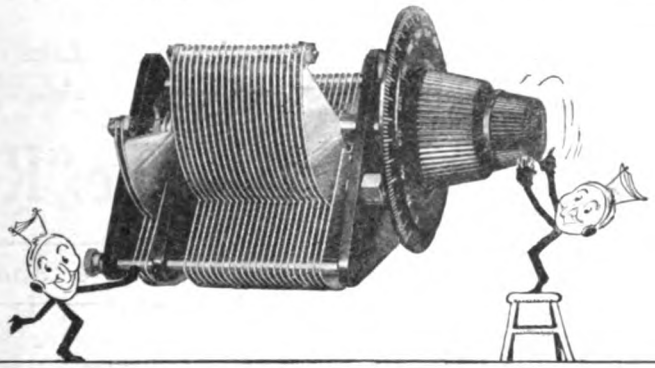

"Some Condenser" Says the "Radio Bug"

Makes your receiving set respond to every broadcasting station operating. The size of the Kellogg Condenser and dial gives easy accurate tuning. The vernier makes unusually sharp tuning a simple matter. The end plates are of the best radio insulation in use today—Bakelite. The Kellogg accurately built dial is also of Bakelite, which retains its handsome appearance indefinitely. Its heavy reinforced construction and beauty of design add to the appearance of any set.

The rotor plates are properly spaced and bolted together, making it impossible for them to make contact with the stator plates. Large bearing surfaces assure smooth, even rotation of the rotor plates and reduce wear to a minimum.

The high class workmanship, with the fine materials used in Kellogg Variable Condensers place them in a class by themselves. The relations of the capacities is such that as great a flexibility as desired in any set may be maintained by the use of the various models.

The resistance to alternating currents at the average wave length is low thus assuring full use of all current intercepted by the antenna.

The Kellogg variable condenser is a precision instrument built in size, proportion and ratio for use as a decrometer or wave meter, as well as for control of capacity in the radio broadcasting and receiving sets. This makes it of far greater value to the amateur as well as the laboratory expert.

Kellogg Variable Condensers are made in the following styles:

Code No.	*Zero Cap.*	*Max. Cap*	*Ratio*	*Price*
601-11 plate Vernier	.000120	.000262	2.1:1	
with vernier All Plates	.000120	.000600	5 :1	$6.75
602-11 plate	.000045	.000396	2.8:1	4.50
603-23 plate Vernier	.000071	.000210	3 :1	
with vernier All Plates	.000071	.000990	14 :1	7.75
604-23 plate	.000071	.000885	12.6:1	5.50
605-43 plate Vernier	.000102	.000250	2.4:0	
with vernier All Plates	.000102	.001800	17.6:1	8.75
606-43 plate	.000082	.001690	20.7:1	6.50

Have your dealer furnish you with Kellogg radio equipment and know you have the best

All Kellogg Radio Parts are manufactured and guaranteed by

Kellogg Switchboard & Supply Company

CHICAGO, ILLINOIS

Columbus, Ohio Kansas City, Mo. San Francisco, Calif. Portland, Oregon

Kellogg Apparatus exclusively is used in building the Symphony Receiver

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Radio Officer N. C. Kumler, graduate of the Radio Institute of America, awarded a gold medal by the city of Los Angeles, and $500 by the Radio Corporation of America for heroic services at the sinking of the S.S. Honolulu.

Wanted— Trained RADIO Men

Over 6,000 operators have already graduated from our school. And many more trained men are needed. Study at home in your spare time.

You may know nothing of radio today. But in a few months study, you can earn your U. S. Government operator's license.

The Radio Corporation of America, which places more operators than any other organization in the world, prefers our graduates, for their thorough training. Many among them have become the biggest men in radio today.

Advanced Radio Course

Great popular demand by the advanced student, experienced amateur, and wireless operator has led to the opening of an ADVANCED HOME STUDY RADIO COURSE, specializing in C. W., I. C. W., telephone and radio measurements. Investigate!

Radio Institute of America

(Formerly Marconi Institute)
Established 1909

322A Broadway, New York City

Indicate by a cross X the course you are interested in:

Radio Institute of America,
322A Broadway, New York.

Please send me full information about radio opportunities today, and your

COMPLETE RADIO COURSE ☐
ADVANCED RADIO COURSE ☐

Name.....

Address.....

.....

Like old Friends— Always Reliable

The "Regal" Line

Biggest and Best in Radio

New "Regal" No. 162 Double Arm Inductance Switch

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of hole. No more chipped panels. Complete with hard rubber Knob and Dial

$1.50

New "Regal" No. 200 Audio Frequency Amplifying Transformer

For clearness of tone, amplification of voice and music from nearby and distant broadcasting stations, is unequaled by any Transformer on the market

3½ to 1 Ratio..... **$4.25**
5 to 1 Ratio..... **4.50**

New "Regal" No. 120 Vernier Rheostat

For fine filament control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market. Complete with Knob

6-Ohms..... **$1.25**
30-Ohms..... **1.25**

No. 140 "Regal" Rheostat

Without an equal for fine tuning. Special base construction—fine filament control

6-Ohms..... **$1.00**
30-Ohms..... **1.10**

Write for folder No. 24 showing 30 big "Regal" items

The American Specialty Co.

Bridgeport - - Conn.

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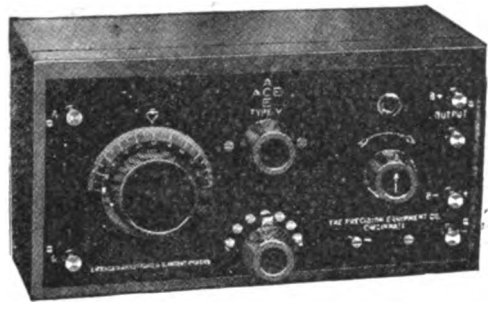
The Gift For That Boy of Yours



Ace Type V

Licensed Under Armstrong U. S. Patent No. 1,113,149

While primarily building Radio apparatus for broadcast listeners, hundreds of amateurs everywhere have learned of the wonderful efficiency of ACE Radio Receiving Sets for amateurs D.X. Radio reception.

With their sharp and efficient tuning range over the broad band of wave lengths from below 200 meters to 600 meters, combining Armstrong Regenerative principles with careful design of parts and elimination of high frequency resistance in each unit, and absolutely free from body capacity effects, Ace Receivers in the hands of the D.X. "ham" will produce better results, tube for tube, than any receiver that you can build or buy.

Almost unbelievable reports of stations copied have been received by the manufacturer from some of the best D.X. men in the business.

Ask your dealer to let you try out an Ace Receiver and you will find that it is just what you have been looking for.

Recommend to some of your young friends who are just entering the game that they purchase an Ace TYPE V $20.00 receiver—for the more advanced amateur, the three tube ACE 3 Combined Regenerative Detector—and two stage Audio Frequency Amplifier—will be the best thing you ever had on your table.

The Precision Equipment Company

Powel Crosley, Jr., President

116 Vandalia Ave., Cincinnati, O.

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RHAMSTINE★

Presents the New VICTOPHONE

—for all Phonograph and Loud-Speaking Horns

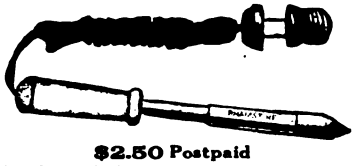
$7.50 Postpaid
Complete with Cord

Relentless research in the field of loud-speaker units has resulted in Rhamstine★ achieving the ultimate in tone and volume. The New Victophone will exceed your expectations; you will appreciate its superiority upon comparison with other loud-speakers. Every part of this new Phonograph unit was designed and built to excel in efficiency and in beauty all other makes. It can be furnished to fit all phonographs — the Standard Type fits the Victrola, Columbia, Jewett or Sonora. Specify make of phonograph when ordering. List Price, Standard Type, $7.50.

Order the New Victophone and test it before buying any other loud-speaker

The Rhamstine★ Electric Solder Set

New Round Type



$2.50 Postpaid
Complete with Cord, two-piece Plug and Solder

Here is the new model—round type—electric solder set. A more handsome and heavier iron than the original flat model. The tip is easily replaced when worn out. Especially adapted for radio work. It is highly plated and polished. Can be used on 110 volts A. C. or D. C. Guaranteed one year. Order an electric solder set and solve your soldering problems. Only $2.50 pospaid.

Manufactured by

J. THOS. RHAMSTINE★

Woodbridge at Beaubien **Detroit, Michigan**

**Maker of Radio and Electrical Products*

RADECO SAFETY FUSES

(Patented)

Now available for

DEALERS' SALE

Radio users have learned that *Radeco Safety Fuses* are a necessary tube protection—that their price (50 cents) is small compared with the great service they render.

The merit of the fuses, their low price and our extensive advertising have created a ready style.

Up to now these fuses have been sold direct by mail, but the demand is so great that we want to distribute them in larger units through the trade channels. You will find *Radeco Fuses* a profitable item to add to your stock.

To assist you in handling them, we have made up attractive display boxes in colors containing an assortment of two dozen fuses.

Price per box (2 dozen fuses)

$12.00

Subject to Regular Trade Discounts

ORDER TODAY

Radio Fans! Radeco Fuses can now be purchased at your Dealers.

RADIO EQUIPMENT COMPANY

New England's Oldest Exclusive Radio House

20 STUART STREET **BOSTON, MASS.**

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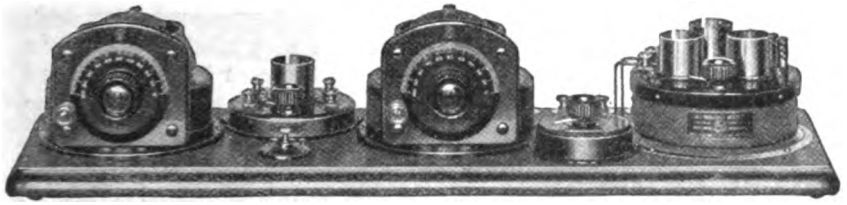
ATWATER KENT

RADIO EQUIPMENT



Atwater Kent Model 9 Receiving Set

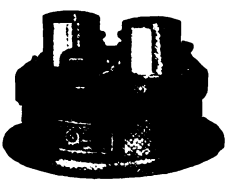
ATWATER KENT Receiving Sets are a truly remarkable achievement. Their wide range of operation; the volume and clearness of tones obtained from distant points, together with the ease with which desired broadcasting stations can be tuned in are the outstanding features of their unusual performance.

The ATWATER KENT Loud Speaker will give you a new conception of clear reproduction:—the true gift of the broadcasting artist is brought undistorted into your home.

If you are now working with a one-tube set, the ATWATER KENT 2-Stage Amplifier will give you the necessary volume to use a loud speaker.

ATWATER KENT Radio Equipment includes complete sets and every instrument necessary for the assembling of complete sets.

Atwater Kent Loud Speaker



2-Stage Amplifier

Literature describing the entire line of Atwater Kent Radio Sets and Parts sent on request

ATWATER KENT MANUFACTURING COMPANY, PHILADELPHIA, PA.
4933 STENTON AVENUE

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"IT'S A MORRISON!"

"Exactly what I wanted—the whole family will enjoy radio now!" Several thousand lovers of real radio will say something like that Christmas morning when they open a package containing "Morrison Loud Speaker." Give a Morrison and you are sure to please.

Attach to your phonograph or use it with a horn. Morrison is the Loud Speaker that reproduces music and voices naturally without vibration—as loud as you like it. You can adjust tone soft or loud by simple turn of thumbscrew on back—no other adjustment necessary—nothing to break or get out of order.

We guarantee your money back if not satisfactory.

Complete with 5 foot cord
Nickel Plated Model

$10

Gold Plated Model

$15

If your dealer doesn't carry it order direct from factory.

Beautifully Illustrated Catalog free on request.

DEALERS

Be sure to stock up now for Holiday business. Orders filled in turn as they come in. Christmas sales will break all radio records. Wire or write today for our special offer.

MORRISON LABORATORIES, INC.
345 Jefferson Avenue, East; Detroit, Mich.

Morrison

Loud Speaker

How?

can you expect good reception, no matter how expensive your set, if you haven't the right plug!

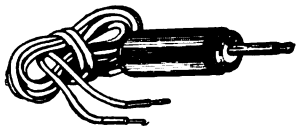
Sounds strange, but the plug is the last link in perfect reception.

The ORIGINAL

COMSCO COMSCO

AUTOMATIC BULLDOG GRIP PLUG

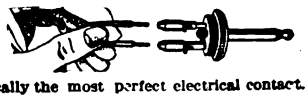
Licensed Under Pat. Pend. Serial No. D 3010—No. 578540



Saves you from short circuits and battery kicks. No more burned out phones or ruined transformers. No more broken finger nails.

Simple to operate

INSERT by a single touch, and the connecting tips of your phone cords accomplish automatically the most perfect electrical contact.



RELEASE by pressing the small knob and the tips will slide out easily without pulling the electrical contacts.

For one pair phones $1.00
For two pair phones $1.50

For sale at your dealer. Otherwise send us the purchase price and you will be supplied.

GENERAL INSTRUMENT CORP.
123 LIBERTY STREET
NEW YORK CITY

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This FREE BOOK on RADIO

Has Shown Thousands How to Make More Money

This wonderful book has opened the eyes of thousands to the amazing Big-Money Opportunities opening right now in Radio. It has shown them how **they** could get their share of the tremendous profits of this newest and fastest growing world industry—**regardless** of what their previous training or experience had been. Hundreds of men today are earning far more than they ever did before—all through having read this Free Book of Radio Opportunities, which we will mail to you without the slightest obligation on your part.

Scores of New Opportunities Waiting for YOU in RADIO!

In the entire history of industry, there probably never has been a business development which can compare with that of Radio! Within a few years it has jumped into the ranks of the world's largest and most profitable fields of endeavor. Broadcasting stations are springing up all over the country. Hundreds of thousands of receiving sets are in operation. Hundreds of ships are installing more and latest equipment. Radio is everywhere being adopted in business. $100,000,000 was spent last year just for receiving sets alone.

This amazing expansion of Radio has opened up hundreds of new positions on land and sea. It has created opportunities never dreamed of in other fields. Big money—fascinating work—advancement—a **real future** in the world's fastest growing industry!

Easy to Learn Radio at Home

If you are ambitious—if you are looking for a field where opportunities are unlimited—get into Radio. Become a Certified Radiotrician—become a highly trained specialist in a new, uncrowded profession.

What Free Book Has Meant to Just a Few of Our Recent Graduates

Triples His Salary As Radio Engineer

Thanks to your course and help it gave me, I have had another boost in pay. This is the third one in less than a year. Today I am getting three times as much as I got before I began your course.
MERLE WETZEL,
Chicago Heights, Ill.

$300 a Month And All Expenses As Salesman

Your course was worth $5000 to me, but I wouldn't take ten times that for the value I've gained from it. I signed up with a company for $300 a month and expenses paid. I owe this to your course.
EMMET WELCH,
Peculiar, Mo.

Prepares For All Radio Jobs

It will interest you to know that since completing your course I was 1st operator on Steamship Lake Gillespie. Last summer I had charge of Broadcasting Station WIAT, and in December connected with the Colin B. Kennedy Radio Corp., as sales correspondent, handling all technical inquiries which I enjoy immensely. All due to N.R.I.
WILLIAM WEST,
St. Louis, Mo.

Thousands of Certified Radiotricians are needed to **operate broadcasting stations**; to design radio sets; to repair and sell radio apparatus; to take charge of radio departments; to operate on board ship or at commercial and government land stations; to go into business for themselves; to fill the hundreds of attractive positions in this wonderful new field.

And now you can easily and quickly qualify in your spare time at home through the help of the National Radio Institute, one of the oldest and largest radio schools in the world. Hundreds of graduates of this school are today profiting by the amazing demand for radio experts. Prominent radio experts help you in your training. Valuable radio instruments for practical instruction supplied free with the course. The same training which has helped hundreds of our students to big positions in radio is open to you.

Enroll Now—For a limited time we are offering our wonderful course at a big saving to encourage as many as possible to enroll at once and help us fill the demand.

Big Free Book Describes Amazing Opportunities

Learn more about this wonderful field of radio and what it can mean to you. Read about the opportunities open—their pay—how our method quickly trains you—what our graduates say—what they are doing—and what you can do. There's no obligation in sending for this free book. You have everything to gain—and nothing to lose. Send for this book today—the book that has meant more money to hundreds of our graduates. Mail the coupon **NOW. NATIONAL RADIO INSTITUTE, Dept. 32AA, Washington, D. C.**

FREE BOOK COUPON

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Washington, D. C.

Without obligation, send me your free book "Your Opportunity in Radio," which tells all about the opportunities in Radio, how spare time study at home will qualify me quickly as a Certified Radiotrician so I can get one of these splendid positions and how your free Employment Service helps me to secure a big pay job.

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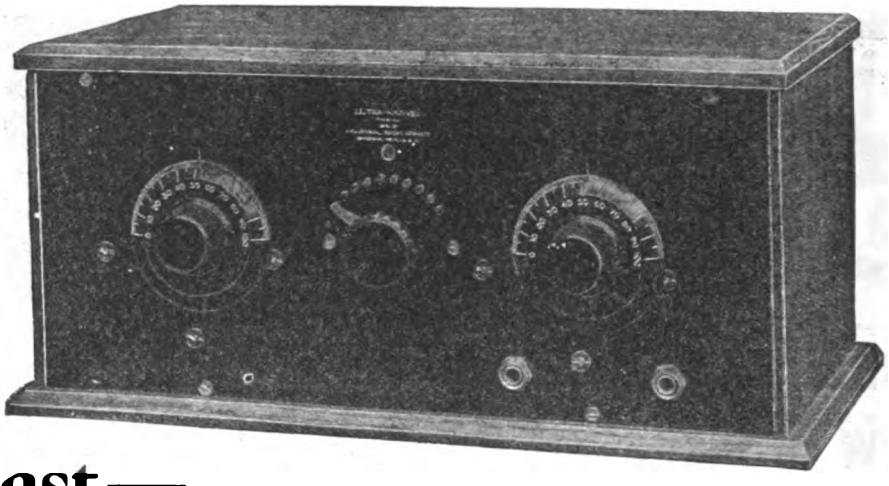


at last—

an Efficient 3-Tube Radio-Receiver Within the Reach of all!

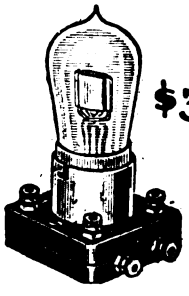
AT LAST—You can now secure a Radiophone Broadcast Receiver with an efficiency equal to any of the high priced sets for only $70. The Ultra-Marvel has a wave length range of 225 to 575 meters with maximum efficiency on all waves and has a conservative range of 1,000 miles with a volume sufficient to operate a loud speaker satisfactorily. Can be used with inside antenna (wire stretched around room) if desired. It is small, compact, very easily tuned and highly selective. Two stages of radio frequency amplification, rectification and one stage of audio-frequency amplification are secured with but THREE TUBES. This receiver can be installed by anyone and operated successfully anywhere.

The construction of this instrument has been greatly simplified and yet is mechanically perfect. It has not been necessary to combine cheap materials to offer it at such a low price.

The Ultra-Marvel is a beautiful instrument with EVERYTHING INCLOSED in a handsome cabinet. By far the most efficient Radio Set ever produced for less than $150. If your dealer cannot supply you write direct for literature and full information to

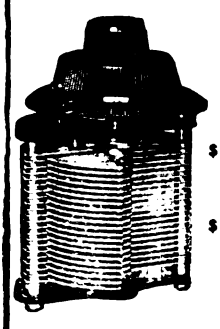
INDUSTRIAL RADIO SERVICE, Newton and Rust Aves., Saginaw, Mich.

UNITED



$3.50

Radio Frequency Unit



$2.25 to $6.50

Condensers
Vernier and Plain

Make Your Tubes Give You Full Service!

Just as several messages pass over the line at the same time in modern telegraphy, so in the modern Radio circuits two frequencies can be amplified by the same tube.

Our Engineers have perfected the United Radio Frequency Transformer. Its success in reflex circuits, when used with United Audio Frequency Transformer has been so pronounced as to be the outstanding advance in Radio this season.

To get the best results from the circuits you use to build your set, you must use the parts stipulated in the circuit diagram.

Our reflex circuit is yours for the asking. Its long distance reception and strength of signals will both please and surprise you, but it must be built with United parts, we cannot recommend it otherwise.

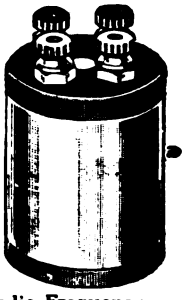
Special Transformer

We are in a position to supply special Transformer, having Split primary and secondary, adaptable for Push-Pull circuits. Price $11 per pair.

UNITED MFG. & DISTRIBUTING CO.
9704 Cottage Grove Ave., :: Chicago
New York Office: 50 Church Street, N. Y.
San Francisco : 709 Mission St., San Francisco, Cal.

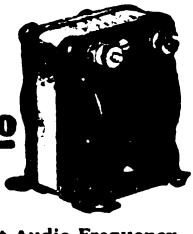
UNITED RADIO PARTS

$2.50



Radio-Frequency Transformer

$4.50



Unit Audio Frequency Amplifying Transformers

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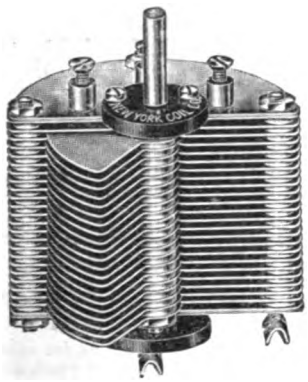
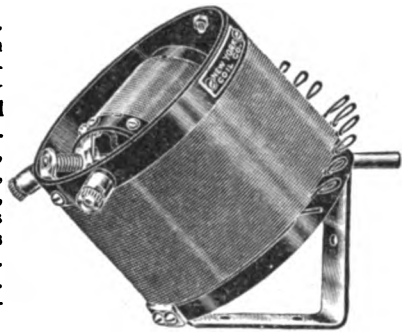
Have An Established Reputation *for* Honest Value, Maximum Results *and* Ease *of* Installing



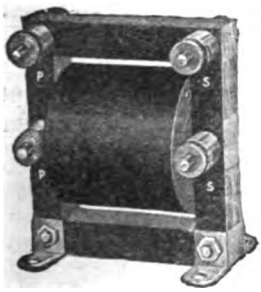
New York 180° Coupler. Is the last word in high grade precision construction and is incomparably superior in both electrical and mechanical details. Genuine Bakelite tubing, double supported solid shaft, double silk wire employed, flexible pig-tail connections with correct number of turns for the new wave lengths. Metal parts nickel plated. **The best buy in couplers. Price, $4.00.**



New York Condensers bring in the broadcasting loud and clear with the true tone, because the construction eliminates all leakage and electrical losses—the standard by which others are judged.

11 Plate	**$1.50**	**43 Plate**	**$3.00**
23 "	**2.00**	**3 "**	**1.25**

Mica Fixed Condensers of tested and permanent capacity, ranging from .0001 to .006, 35 cents to 75 cents, of **superior** quality.



Insist on New York Amplifying Transformers. Do not be satisfied with something claimed to be "just as good." They are universally recognized for their marvelous amplification, purity of tone and ability to produce uniformly perfect results with any style of standard tube. Price $4.00 and worth it.

The New York Variable Grid Leak easily tops the field in precision, permanency and efficiency. **Price, $1.50.** For panel mounting, **$1.75.**

Get literature on *Variometers, Couplers, Mica Condensers, Inductance Tap Switches*

NEW YORK COIL COMPANY

338 Pearl St. **New York City**

Pacific Coast—MARSBANK SALES CO., 1240 S. Main Street, Los Angeles, California

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Right at home you can speedily qualify yourself to accept big paying positions in the great field of Radio. Never before such sensational opportunity. Get in on the ground floor. We start your training by giving you this wonderful tube receiving set. Range up to 1000 miles. ABSOLUTELY FREE. Our practical instruction method guarantees your success—you learn by actual work on the set.

ENORMOUS DEMAND FOR EXPERTS

From everywhere comes the call for Radio Experts. Big salaries are waiting for trained men who can construct, install, operate, repair and sell radio equipment. Tremendous profits can be made in your own neighborhood taking orders for sets. Thousands are winning success in this fastest growing industry—you can too.

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Just a few hours each week of pleasant home study trains you in amazingly short time. Make your spare time earn you cash. We show you how. Many are earning from $3,000 to $10,000 a year.

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A. G. MOHAUPT, Radio Engr.
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Please send me details of your Home Study Course—also your Free "Radio Facts" and information on how I can get a FREE 1000 mile Radio Set.

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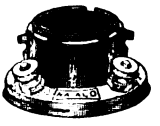
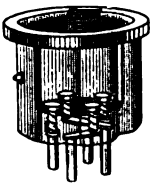
CITY..... STATE.....

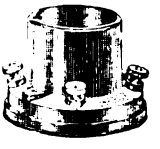
It's the contact that counts



Na-ald Special Socket No. 499 for UV-199 and C-299 Tubes. Price 50c

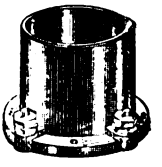


Na-ald Adapter No. 429 for UV-199 and C-299 Tubes. Price 75c



De Luxe No. 400 Price 75c

De Luxe Contact



Small Space No. 401 35c, 3 for $1.00

Na-ald W. D. 11 No. 411. Price 75c

Weak reception due to inferior contacts is banished when Na-ald sockets are placed in a set. Na-ald contacts exert a strong, wiping pressure on tube prongs over a broad surface, regardless of frequent removal of bulbs or variation in the length of prongs.

You can count on Na-ald sockets under all conditions. They are moulded of genuine Bakelite, with uniform cross-section and cure. These features prevent plate-to-grid losses and insure full efficiency from tubes.

Insist on Na-ald sockets and put an end to weak reception. All good dealers carry them.

NA-ALD INSIDE INFORMATION

(No. 429)

Have you realized that the matter of design in anything as simple as an adapter will make a big difference in the results obtained with a U. V. 199 or C 299 tube? Na-ald No. 429 Adapter makes it possible to use these excellent tubes in regular standard sockets. Not only must means be provided for holding the tube, but had we used flat springs or allowed broad flat surfaces to run parallel in this adapter, the capacity would rob this tube of much of its effectiveness. Again, full-surface, positive contacts were necessary. These are provided by plunger pads backed with music wire springs pressing against metal cross-overs moulded in solid Bakelite. Na-ald adapters cost but 75c, a very reasonable price in view of their assurance of the highest tube efficiency.

Alden Manufacturing Company

Largest Makers of Radio Sockets and Dials in the World—Why?

52 Willow St. Springfield, Mass.

Dept. C Cable Address, Aldenco

NA-ALD

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Boys are the Backbone of the Radio Business

The President speaks, and all over the country millions of radio sets are tuning in to catch his words. Four years ago a favored few, living near by, might have listened in. Now the whole country listens. Radio has captured the home, and the conquest was only made possible by the tremendous energy, ingenuity and curiosity of boys.

Boys' imaginations were caught by the lure of radio. They pioneered with their home-made sets. They spent their hard-saved nickels for parts. They enlisted the interest and roused the enthusiasm of their parents. They opened the family coffers. Dad went out to get his son the best he could afford, with son acting as advisor, buyer and constructor-in-chief. And to-day, the vast majority of radio sales are made to boys, or to parents buying for boys or with the boys' advice.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

goes right to the heart of the boy market. It is the favored magazine of 500,000 radio-inoculated boys averaging 15½ to 16 years old—sons of well-to-do parents. Its stories and articles deal with radio authoritatively. All its contents hold their interest and confidence.

Always striving to improve their sets, indefatigable in insistent wanting, commanding their parents' enthusiastic cooperation in their radio activities—these youths are the backbone of the radio business; the radio manufacturer's greatest market.

Copy reaching us by January 15th will catch the March issue.

THE SPRAGUE PUBLISHING COMPANY
(Member A.B.C.)
548 Lafayette Boulevard, Detroit, Michigan

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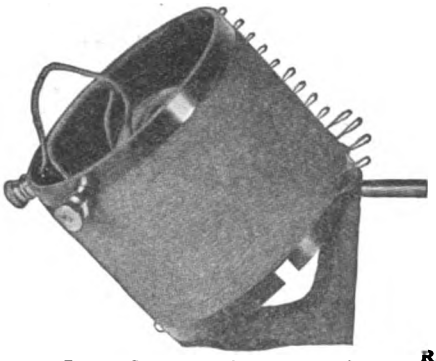


Raven Super 180 Degree Coupler
Catalogue No. B-104

RAVEN RADIO

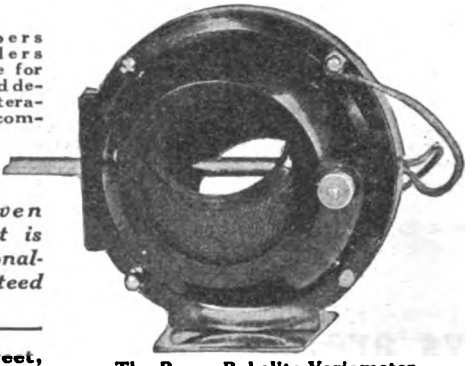
RAVEN INSTRUMENTS have given wonderful satisfaction and our long list of satisfied Jobbers and Dealers prove that our apparatus is the best repeat seller on the market.

Our Variometers and Couplers are made to conform to all wave lengths. Their size makes them adaptable to all circuits. Beautifully constructed of Red Moulded Bakelite, wound with green silk wire and assembled with nickeled brass throughout.

Bakelite Variometer	B-101
Bakelite Vario-coupler	B-102
Bakelite 180° Coupler	B-104
Bakelite Rheostat	B-106
Wooden Variometer	C-101

Radio jobbers and dealers should write for our prices and descriptive literature on our complete line.

Every Raven instrument is unconditionally guaranteed



The Raven Bakelite Variometer
Catalogue No. B-101

RAVEN RADIO, Inc. 8 Learned Street, ALBANY, N. Y.

WEIGHS ONLY 8 OZ

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We Guarantee The *Scientific* Headset to be the greatest value on the market. Try it for five days. If not satisfactory send it back and your money will be refunded immediately. Circular on request. Dealers wanted.

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We believe that you can buy most intelligently when you *can see what is inside.*

Here then is your opportunity to see the care that is built into a Timmons Talker.

Every one of these 16 features is the result of an honest attempt to give you a loud speaker that has the sweetest tone and greatest volume of any non-power loud speaker made.

We hope now that after seeing all of these things that we have tried to do, you will hear the Timmons.

—at your dealer—$35 and $25.

Your dealer has "Volume Without Noise"—the Timmons folder. Or write us.

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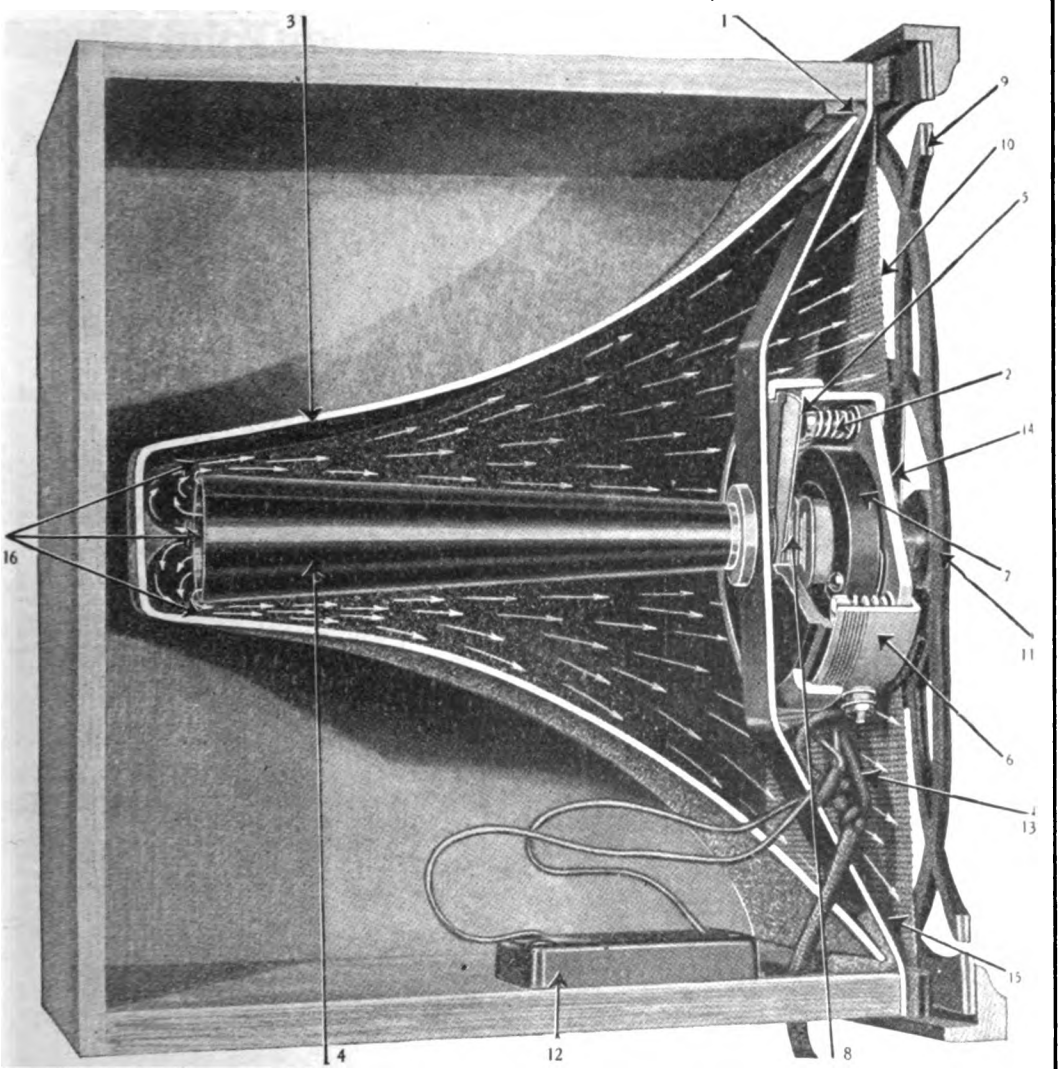

Timmons Talkers

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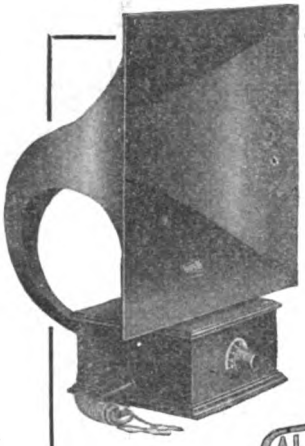

$35.00
Type R-1202

CALLOPHONE

The Height of PERFECTION in Loud Speakers

Smooth, even tones — pleasing volume — even distribution of sound — no metallic vibrations or distortions. These are the achievements of the Callophone — made possible by long experience in voice amplification.

A dial controls the magnets, permitting accurate adjustment to the various conditions produced by different types of tubes and varying strength of incoming signals.

The Callophone can be used on any set equipped for a loud speaker. No extra batteries are required.

Every instrument is tested under actual operating conditions before leaving the factory.

Order your Callophone today! Use it ten days — if it does not do all we claim, return it and your money will be refunded.

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PRICE
35c Mounted 25c Unmounted

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Million Point Mineral CRYSTALS

This remarkable crystal is super-sensitive —reproducing from every point on its surface. Greatly increases both audibility and radius—records having been reported up to 1200 miles. Will not burn out or corrode. M. P. M. crystal is unsurpassed for reception both with or without amplification.

M. P. M.
Reflex Radio Frequency TRANSFORMER

PRICE
$4.50

Absolute precision in the assembling of these transformers assures remarkable range and volume with positive elimination of distortion.

Special Offer

Detailed working diagram of a successful reflex circuit will be sent free with all orders for either crystals or transformers.

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Dept P, 247 South Central Ave.,
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CHICAGO

Getting distance ~ with ease!

ONLY those who have built their own sets experience that priceless thrill of personal achievement which comes surging in with the sound waves caught from afar off.

Tuning out or in at will, erasing interference in favor of the sending point sought, is always most easily accomplished by *synchronized* apparatus.

Don't build mongrel sets. Even if parts used are each of highest quality—but the products of various makers, they will hardly work together as efficiently or harmoniously as if they were the products of one reputable manufacturer. You'll find sets built up of

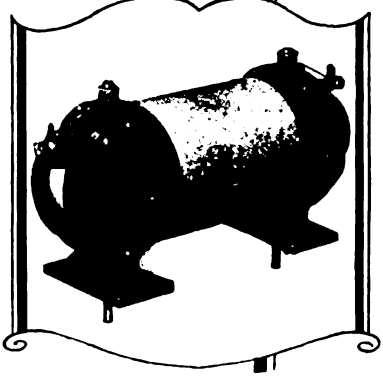
Gilfillan Radio Parts

perfectly synchronized. While these parts will of course do good work in conjunction with apparatus of other makers—the best results—at probably no greater expense, is obtained by using Gilfillan parts throughout.

See your dealer today and have him show you Gilfillan parts. Even on sight you'll appreciate their superiority.

If your dealer does not handle this superior line, write us for name of nearest dealer, descriptive folder and list.

LOS ANGELES



Gilfillan Tuning Unit

Another Gilfillan achievement making for increased simplicity and greater efficiency. This unit replaces two variometers and one variocoupler. Note how compact it is. Wave length range 225 to 890 meters, covering all broadcasting. High selectivity in tuning. Brown moulded bakelite. Split bronze bearings. Net weight 22 oz. Height 4⅝". Diameter 3⅛" Length 8¼"

GILFILLAN BROS. INC.

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Licensees General Bakelite Co.

Genuine Gilfillan Radio Parts can always be identified by this trade-mark —look for it

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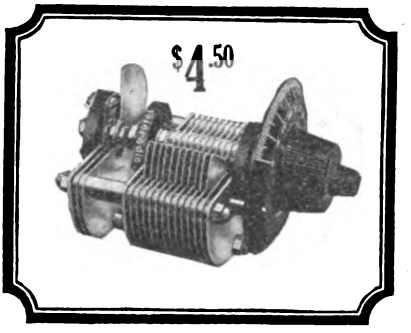
Teleradio



Continuous Satisfaction

The expectations of the radio enthusiast who is endeavoring to get sharp tuning in his set, are fulfilled by the continuous satisfaction of the Teleradio Vernier Condenser.

His joy in finding accuracy and dependability in this instrument reflects the efforts of the manufacturer to fully please the owners of Teleradio products.

With extra heavy polished hard aluminum plates that will not warp, a special locking feature preventing short circuiting of vernier and providing permanent and perfect contact, an accurate and constant capacity, and with rigid construction throughout, there is positive assurance of continuous satisfaction from this precision instrument.

Guaranteed electrically and mechanically.

TELERADIO ENGINEERING CORP.
488-490 Broome Street New York

FILAMENT RHEOSTAT

Is reversible and can be mounted on either panel or base. Double brass bearing on spindle insures smooth action and prevents looseness. Contact arm is phosphor bronze. Will carry 1½ amperes without heating. Price (6 or 30 ohm).....$1.00

VERNIER CONDENSERS 23 plate $4.50; 43 plate $5.50; VARIABLE CONDENSERS 3 plate $2.00; 11 plate $2.50; 23 plate $3.00; 43 plate $5.50; HEAD PHONES 2000 ohm $5.50; 2200 ohm $6.00; 3000 ohm $7.00; LIGHTNING ARRESTER $1.00.

TELERADIO PRODUCTS

RECTIFIERS
POCKET METERS
FILAMENT METERS
How Many of These
Sterling
RADIO NECESSITIES
Are You Using?
YOU SHOULD BE FULLY EQUIPPED TO GET REAL RADIO ENJOYMENT
☐ PORTABLE RECTIFIER. For charging batteries from 110 volt A.C. circuit. Absolutely safe. Cannot overcharge. No freezing or sticking. Charged by 5 ampere maximum rate. 50 to 60 cycle, 6 volt, $16.00; 25 cycle, $18.50. Add $1.00 West of Rocky Mts.
☐ 12 POINT ROTARY SWITCH. Improves appearance of board contact points—a complete unit for rear of panel mounting to which variocoupler taps may be easily soldered. $1.50.
☐ FILAMENT RHEOSTAT. Fine adjustment. May be used for either back of panel or table mounting. Types especially designed for various tubes. 75c. and $1.00.
☐ AUDIO AND RADIO FREQUENCY TRANSFORMERS. Audio in 4 to 1 and 6 to 1 ratios, give high amplification without distortion. Shielded type protects from influence of stray fields, $4.00. Radio in fixed and tuned range types give sharp tuning and high selectivity of resonance. $4.00.
☐ POCKET METERS, voltmeters, ammeters and voltammeters to cover all the needs of the radio battery user for testing "A" and "B" Batteries both dry and storage. Draw just right amount of current from battery. Thoroughly accurate. $1.00 to $4.00.
See Your Dealer for These Items or check any of above on which you want further information.
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AUDIO & RADIO TRANSFORMERS

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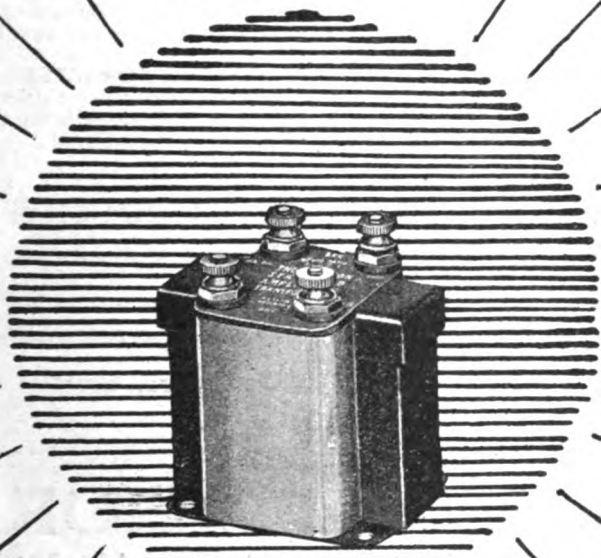
SUPER TRANSFORMER

AUDIO FREQUENCY



THE CROWNING GLORY
OF THORDARSON ACHIEVEMENTS

EQUAL AMPLIFICATION OVER
THE ENTIRE MUSICAL RANGE

THORDARSON
ELECTRIC MFG. CO.

Huron and Kingsbury Streets Chicago, Ill.

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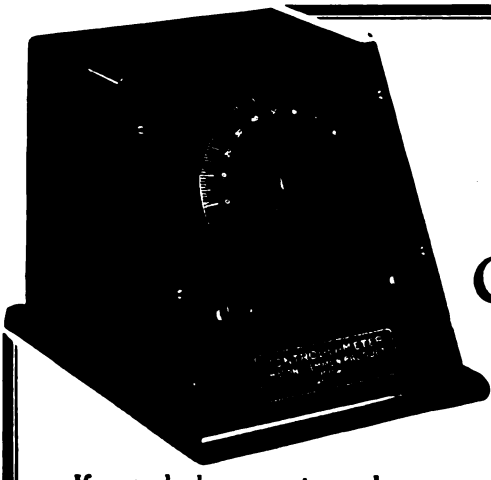

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$12.50
POSTPAID

Results— Right Now!

WITH A

CONTROL-O-METER

Wherever you are located, the **CONTROL-O-METER** will permit distant programs to be received right through the local broadcasting stations.

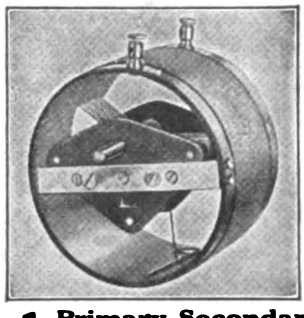
Each **CONTROL-O-METER** is individually tested in our Laboratory and a Chart provided showing the setting for each wave length.

The **CONTROL-O-METER** has made good in the most congested radio districts of the United States. You will get results the moment you turn the dial.

MALONE-LEMMON PRODUCTS
Made by STEPHENSON LABORATORIES
342 MADISON AVENUE
NEW YORK CITY

TWO POPULAR DEVICES!

HORNE
"VERNI-TUNER"
Price $5.00



3 in 1 Primary, Secondary and Variable Condenser

Combined fixed coupler and Variable Condenser

For constructing all Regenerative Circuits, Radio Frequency, Reflex and Tuned Radio Frequency.

No Taps — Extreme Selectivity — Free "Hook-Ups" with each device. VERNI-TUNER WAVE TRAP for all sets in cabinet with Bakelite Panel and Binding Posts..... **$8.50**

HORNE RADIO

HORNE
TUBULAR VARIOMETERS

Substantial Black Tube
No wood or Heavy Dielectric

No. 313 Radio Frequency Variometer....	$6.00
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No. 315 Plain Variometer.....	5.50

At your dealer, or mailed direct upon receipt of purchase price. Booklet of 10 latest radio circuits, 20c.

HORNE ELECTRIC & MFG. CO.
Mercer & Colgate Sts., Jersey City, N. J.

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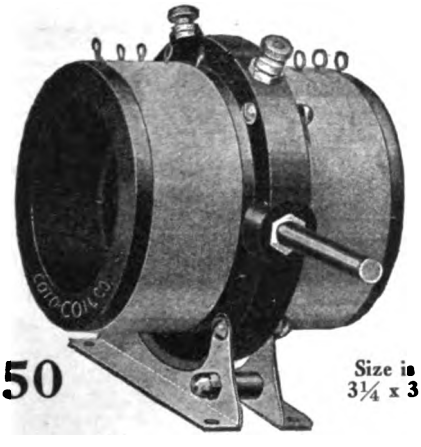
Coto

"Built First to Last"

Build Your Own Set And Build It Compact

Your radio dealer will recommend a good dependable and selective circuit. He will advise you, work with you, and make your success easy. A set assembled from Coto Compact Radio Parts, will be worth double its cost, especially next summer when you will carry it along on radio outings.

Insist on Coto Quality and Coto Compactness



$5.50

Size is only 3¼ x 3 x 3¾

New Coto Compact Moulded Variocoupler

In polished brown bakelite. Range is 200 to 600 meters. Has eight taps for use with primary condenser. Pigtail connection to rotor. Base or panel mount. Type 9000.

Dealers! Jobbers!

You can jump right into selling volume on the Coto Compact line because quality is right and demand established by national advertising.

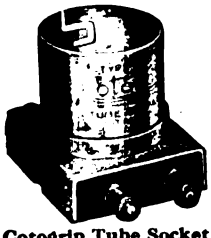
COTO-COIL CO., 87 Willard Ave, Providence, R.I.

BRANCH OFFICES

Los Angeles, 329 Union League Bldg.
Minneapolis, Geo. F. Darling, 705 Plymouth Bldg.
Atlanta, C. P. Atkinson, Atlanta Trust Co. Bldg.

Coto Compact Air Condenser with Vernier
Only 2⅞ inches square. Rotor plates soldered to shaft. Stator plates soldered at three points. .0005 Mfd. $5. .001 Mfd. $6.

Coto Compact Variometer
Especially designed for new wave lengths, 200 to 600 meters and for the much demanded compactness. Size 3¼ x 1¾ x 3¾ in. In brown polished bakelite with honeycomb wound stator. Pigtail connections to rotor. Base or panel mount. Type 8000... **$5.00**



Cotogrip Tube Socket
Has unique double positive grip of tube terminal posts. Best hard rubber insulation. Type 7000. 85c

Coto Special Audio Frequency Transformer
Turn ratio of 3 to 1. Coto quality throughout but made to sell at a popular price. Type 4500..... **$2.50**

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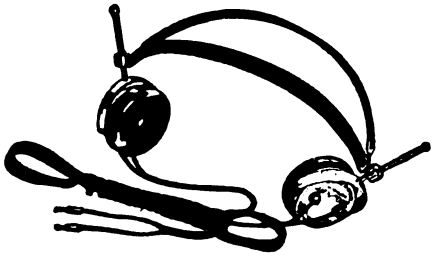
AMPL-TONE PHONES



ALWAYS FRESH
Sample to dealers $3.20

This is our only ADVERTISEMENT

It sells our entire product
Merit does the rest for us

C. M. FRENCH MFG. CO.
SEYMOUR, CONN.

Fits Anywhere

The same range of reception for which you now require a 100 foot or longer aerial.—infinitely improved upon by the ***Warren Radio Loop*** that fits into a coat pocket. Interference eliminated. Selects and tunes with remarkable ease and accuracy. All enclosed by Bakelite shields. Four compact sizes for every purpose. The best known—the best liked.

Write for the name of the nearest Warren dealer and Bulletin I-102.

Type A-727 (300-700 meters) 6 inches square—non-directional.....$10
Type A-7236 (175-1000 meters) 6 inches square—non-directional.....$12
Type B-2537 (300-700 meters) 18 inches square—directional.....$20
Type BL-2520 (200-18,000 meters) with honeycomb coil mounting. 18 inches square—directional.....$25

Send for Bulletin I-102
V-DE-CO RADIO MFG. CO., Dept. F, Asbury Park, N. J.

The New Freshman
CAPACITY FINDER

permits you to actually measure the condenser values necessary in your hook-up

31
CAPACITIES FOR THE COST OF
5

FIND OUT
just what value of a condenser will give your hook-up the best results in the grid circuit, across the phones, in the Antenna Circuit, across transformers, battery circuits, etc.

Price $2.25
including the 5 special Freshman Condensers.

At your dealer, otherwise send purchase price and you will be supplied postpaid. Ask your dealer or write direct for complete instructions free.

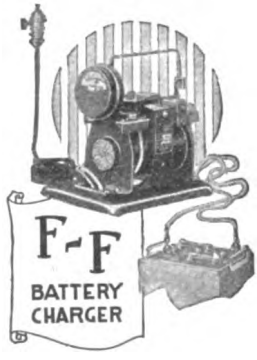
Chas. Freshman Co. Inc.
Radio Condenser Products
106 Seventh Avenue **New York**

The Satisfactory Charger For Ten Years Past

The F-F, the first successful mechanical charger, is now the most popular. F-F features are distinctive, its construction is simple, and the absence of breakable parts which are expensive to replace, is almost sufficient reason for you to own the F-F; but the satisfaction you will buy with the low purchase price of the F-F is further reason why you should insist on the F-F.

Buy from your dealer. There's a type for every need. If he cannot supply you, write for literature or enclose remittance covering express or postal charges on 9 lbs.

IT'S FREE—Write for Bulletin No. 44



$15.00
F. O. B. Cleveland

Type 6 charges 6 volt Storage Battery from any 110 Volt 60 Cycle lamp socket at average rate of 6 amperes, or over if battery needs it.

The
France Mfg. Co.
10444 Berea Road
Cleveland, Ohio

Oldest Manufacturer of the First Successful Mechanical Charger

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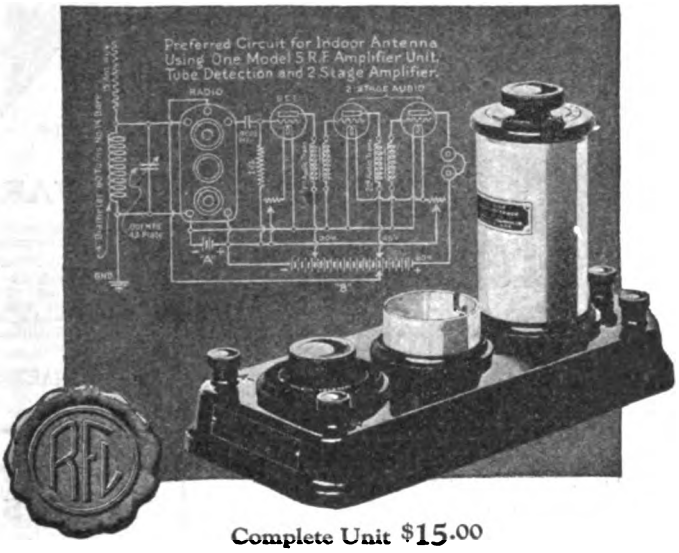
RADIO FREQUENCY AMPLIFICATION

WITH

Ballantine Variotransformers

(Patents Pending)

Model 5 $9.60



Complete Unit $15.00

"TURN THE KNOB"

1. Continuous variation in wave length.
2. Self-contained and shielded.
3. Control of regeneration and tuning by single knob: *no potentiometer.*
4. Fits your set — either base or panel mounting.
5. Improved tone quality.

"Radio Frequency Amplification with the Ballantine Variotransformers" — a 25-page booklet — mailed free on request.

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Pioneers in Bakelite Moulding

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the complete MURDOCK LOUDSPEAKER for $5.00

the new MURDOCK PLUG-JACK for $1.00

a pair of MURDOCK HEAD PHONES $4.00 or $4.50

best in radio

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If your dealer cannot supply you, send money direct and your order will be promptly filled.

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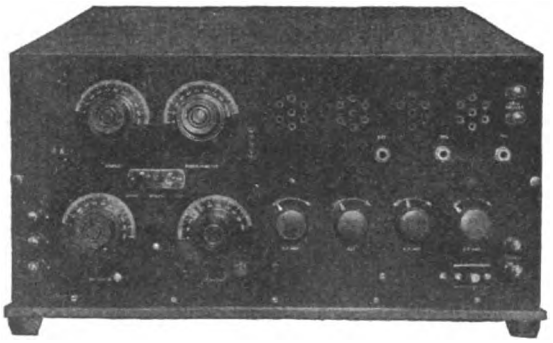
354 Washington Ave., Chelsea, Mass.

TYPE R-B-4



This is the set you have been looking for, and the one that you need.

Having one stage Radio Frequency, Tuned Impedance, Detector and Two Stages of Audio Frequency.

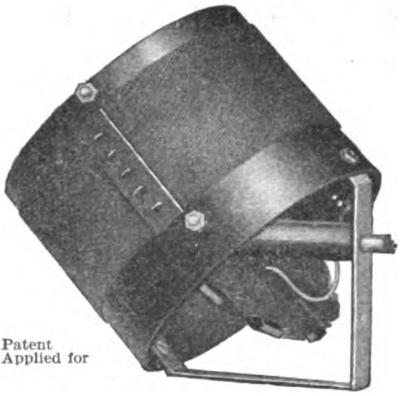
All apparatus mounted on panel 10 inches high, 21 inches long, and set in panel cabinet 10 x 21 x 10 inches deep.

Price $125.00 without tubes or batteries

WIRELESS ELECTRIC CO.

204 Stanwix St. Pittsburgh, Pa.

HARTMAN



Patent Applied for

$4.50 VARIOCOUPLER $4.50

Here is a distinctively high grade Variocoupler at an exceptionally low price.

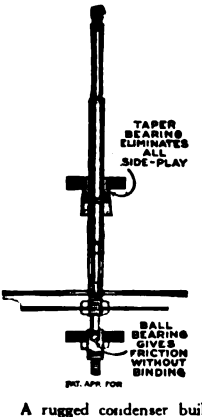
Check the following points and verify this claim.

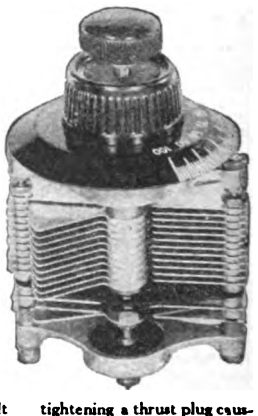
(1) Spider web rotor. The only means of obtaining minimum coupling. (2) Pig tail contacts. (3) Bakelite tube. (4) Green silk wire. (5) No live brackets. (6) Improved taps. (7) Dead shaft and no capacity effect in tuning. (8) 180° dial adjustment without the rotor being submerged in stator field.

THE HARTMAN ELECTRICAL MFG. CO.

Mansfield, Ohio

For Sturdiness and Accuracy Use Lombardi Condensers





A rugged condenser built on an entirely new principle, made to last a lifetime. The tension is adjusted by tightening a thrust plug causing the proper tension between a hardened steel ball and a 45 degree tapered brass bushing.

Also makers of coils and sockets.

Literature and prices furnished upon request

Lombardi Radio Mfg. Co.

67 MINERVA ST. DERBY, CONN.

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Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

A. J. HAYNES

Assoc. Institute of Radio Engineers

Designer of the Haynes Circuit described by Mr. Cockaday as the ideal tuning element of the Super-Heterodyne.

The Simplified Super-Heterodyne

Not in several years has any series of articles on radio attracted so much favorable attention as the description of the* HAYNES CIRCUIT, *written by Laurence M. Cockaday, and published in the September, October, November, and December (1923) issues of "Popular Radio".

Besides describing the circuit which has become generally known "1,000 miles for $15" these articles also tell how to construct the special units which, when used with it, constitute the Simplified Super-Heterodyne.

SEPTEMBER

In this first article (published in the September issue of "Popular Radio"), Mr. Cockaday tells how to make the Haynes Circuit—the finest one-tube receiver that can be built. Combines wonderful selectivity and extreme long distance range with a simplicity of construction never before equalled. 1,000 miles for $15.00.

OCTOBER

In the October article Mr. Cockaday explains the first addition that the ambitious experimenter can make to his original Haynes Circuit. He describes the Haynes Two-Stage Audio Frequency Amplifier, which converts the Haynes Circuit to a three-tube receiver, permitting the use of a Loud Speaker.

NOVEMBER

The November article is regarded by many as the most important contribution to radio in the last year.

Mr. Cockaday describes the construction of a Separate Oscillator — the first step necessary to the construction of a simplified Super-Heterodyne circuit using the Haynes Circuit as the tuning element.

DECEMBER

And finally in the December issue Mr. Cockaday describes the construction of the Intermediate Wave Radio Frequency Amplifier.

In this concluding article is explained how the four units combined constitute a complete Super-Heterodyne receiver—the Master DX Receiver of the Age, the Rolls Royce of Radio.

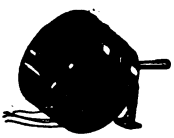
Haynes-Griffin Transformer

$4.25

A new air core radio frequency transformer sharply tuned to 3,000 meters. Upon the use of this transformer depends much of the success of the simplified Super-Heterodyne. Haynes-Griffin Input Transformer also $4.25.

Special Oscillator Coupler

$3.50



Specially designed by Mr. Haynes for use in the Super-Heterodyne. An indispensible adjunct for the proper operation of this wonderful circuit.

NOW WE ARE READY

The tremendous public interest displayed in these articles left us temporarily short of material, with resulting slow shipments. Now, once again, Haynes-Griffin with added space, increased manufacturing facilities and enlarged personnel, is ready to render its usual prompt, efficient service.

We are prepared to furnish the identical apparatus recommended by Mr. Cockaday without changes or substitutions of any kind.

Send for FREE LEAFLETS telling how to construct the Haynes Circuit and the Super-Heterodyne. Use the handy coupon.

Parcel Post Prepaid in U. S. anywhere east of the Mississippi River

New York's Largest Radio Store

Haynes-Griffin,
41 West 43rd Street,
New York City.

Send me at once complete data and prices on all material mentioned in Mr. Cockaday's articles describing the Haynes Circuit and the Super-Heterodyne. I enclose a two-cent stamp for each of the leaflets checked below.

Haynes Circuit ☐ Separate Oscillator ☐
Haynes Amplifier ☐ Intermediate Amplifier ☐

.....

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HAYNES-GRIFFIN RADIO SERVICE, Inc.
41 West 43rd Street, New York City

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THE NEW
METALECTRIC SOLDERING IRON

Operates with the Simplicity—
Ease and Efficiency of a
Pencil on any Electric Current

ACCEPTED
As the Logical Solution
to Radio Soldering
Problems

Ample Heating Capacity
Handle Always Cool

$5.50
"Worth It"

"An All-metal
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Radio
Veterans
Demand

"Dependable"
TRIMM HEADSETS

"Professional" $7.65 "Dependable" $5.00

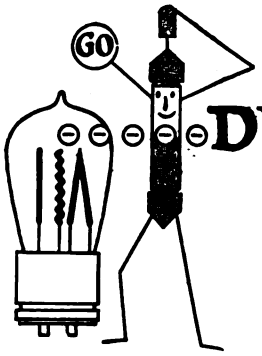
Positively the only headset on the market sold with a lifetime guarantee that covers every detail of materials and workmanship, excepting only cords and shells which cannot be guaranteed against breakage if dropped. Absolutely no charge AT ANY TIME for repairs, replacements or re-magnetizing. The headsets to buy and to sell.

See! Hear! These
TRIMM LOUD TALKERS
All fitted with Special TRIMM jumbo size loud talker unit

ACOUSTICOLA	Phonograph Attachment	$10.00
ACOUSTICOLA	with composition horn	22.50
ACOUSTICOLA GRAND	with cast aluminum horn	35.00

Write for folder. Or order samples with privilege of return after 5 days examination and test

TRIMM RADIO MFG. CO.
Dept. 59, 24 S. Canal St., Chicago



Do your tubes st-tut-tutter ?

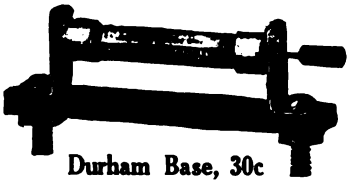
DURHAM Variables
Will stop it

Just a touch of the plunger clears out that mush and makes way for real DX.

No. 101—0.1 to 5 megohms for soft tubes

No. 201A—2 to 10 megohms for hard tubes

75c



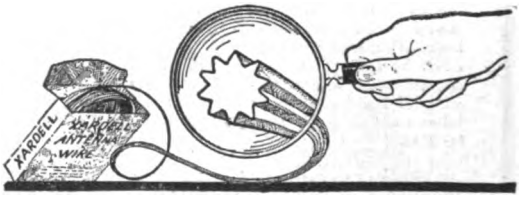
Durham Base, 30c

FREE folder tells how variable grid leaks work. Ask your dealer for copy

DURHAM & CO., Inc.
1936 Market St., Philadelphia

Dealers: These units will clear up your sales troubles, too. For, DURHAMS give guaranteed satisfaction.

DX-10-POINT



ANTENNA WIRE

$2.00
PER
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FEET

Designed for long distance reception and is different and better than the usual make-shifts, being hard drawn from the finest copper, having a corrugated surface with ten collecting points on the circumference. This gives a greater collective surface to the high frequency radio currents. The result is extreme sensitiveness and increase in range and clearness of any set from the simplest Crystal to the finest multiple tube receiver.

Use this antenna wire and enjoy the full possibilities of your set.

Sold in coils 100 feet, 200 feet and 500 feet. Order direct or from your nearest dealer.

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Xardell Corp.
UTICA, NEW YORK

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O'NEIL AUDIPHONE

THE *eventual* radio reproducer, designed on phonograph principles and built by electro-acoustic engineers and phonograph craftsmen. The *O'Neil Audiphone* marks the departure from the common earphone type of loud speaker, and the adaption of phonograph reproduction to radio.

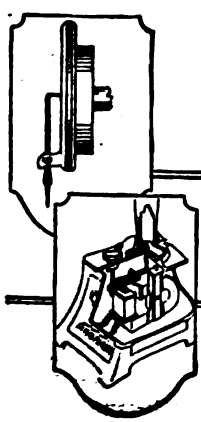
The "laminated voice core" displaces the usual headphone magnets, amplifying *all* the music, yet without extra batteries. The result is the actual music itself, unaltered, real as the original, uncannily NATURAL. The patented, external adjusting feature enables you to regulate the AUDIPHONE to individual receiving conditions.

Complete with 5 feet connecting cord.

PRICE

$25

Hear the radical improvement in radio reception at the nearest *Audiphone* dealer. Write us for his name and for literature.



Note the similarity of construction between the phonograph reproducer (illustrated in the upper panel) and the reproducer of the O'Neil AUDIPHONE (below): both have a mica diaphragm set in a sound-box chamber and actuated by an elbow stylus bar. The principle of sound production is the same, resulting in perfect reproduction.

O'Neil Mfg. Co.

714 Palisade Ave. West New York, New Jersey

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RATHBUN
SINGLE-HOLE MOUNTING

SUPERIOR CONDENSERS

NOT a particle of steel or iron in **Rathbun Condensers,** hence no stray magnetic fields. Further evidence of the experience and conscientious forethought behind each Rathbun Condenser. Other points of superiority are single-hole mounting, long brass bearings, anchored stator plates, precisely spaced, and a perfect concentric shaft. Write for the complete evidence and the name of the nearest **Rathbun** dealer.

LIST PRICES

Plain Type

5 Plate	.000125	$3.00
11 "	.00026	3.00
23 "	.0005	3.50
43 "	.001	4.50

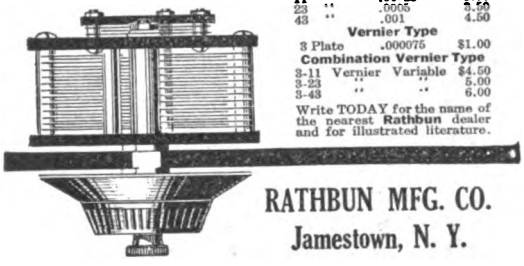
Vernier Type

3 Plate	.000075	$1.00

Combination Vernier Type

3-11	Vernier	Variable	$4.50
3-23	"	"	5.00
3-43	"	"	6.00

Write TODAY for the name of the nearest **Rathbun** dealer and for illustrated literature.



RATHBUN MFG. CO.
Jamestown, N. Y.

The Saturn

"Above the Ordinary" Radio Products

Automatic Plug

Phone cords connected, disconnected in a moment. Pulling on cords automatically tightens grip, lever instantly releases. No taking apart or soldering. List Price **$1**

Perfect Jack

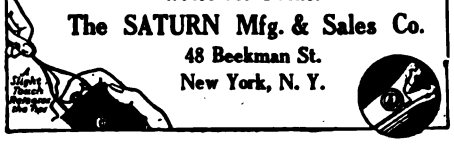
Easy soldering crowfoot—off-set terminals with solder flux compound, nickel-plated rounded corner brass brackets, spring German silver blades and sterling silver contact points.

List Prices

No. 1	Single Circuit, Open	50c
No. 2	" " closed	55c
No. 3	Double " "	70c
No. 4	Single Filament contro	75c
No. 5	Double " "	80c

Write for Folder

The SATURN Mfg. & Sales Co.
48 Beekman St.
New York, N. Y.



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and other standard manufacturers

We carry a comprehensive stock of the latest receiving sets, parts and supplies of the leading manufacturers, and ship from stock promptly.

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DEALERS: Buy reliable equipment from a house of established reputation. Send for catalog of tested and approved apparatus, and our discount sheet.

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Distance & Volume

are found in

RayCoils

RayCoils "A" for Reinartz, Ray Coils "B" for RCS and Ultra Audion Circuits, RayCoils "C" for RCS, Ultra Audion and Tuned Radio Frequency for All Circuits. "D" for Neutrolizing Circuits 4 & 5 Tubes.

A = $2.50
B = 2.00
C = 2.00
D = 2.00

Use the RCS Circuit with or without Radio Frequency for Simplicity in operation and results. Not equalled by any set for volume and distance.

Coils in Separate Box
With Wiring Diagram

Working **Blue Prints** of four sheets 12 x 18 of all standard circuits, such as The Variometer, Reinartz and RCS one and three tube sets. 50 cents a set.

If your dealer cannot supply you, send direct to us and we will mail them post paid anywhere in the U. S. A.

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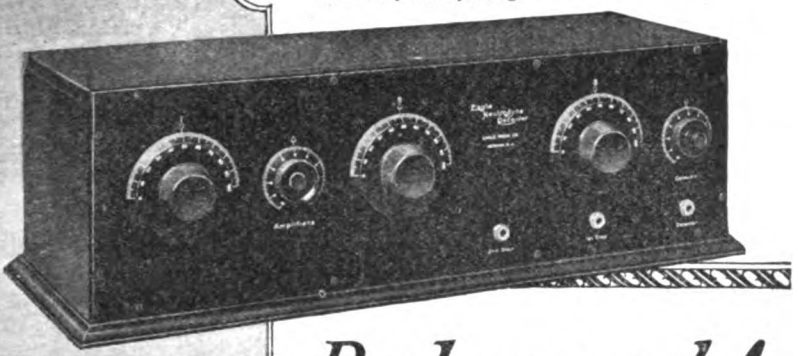

Balanced!

THE portals of advanced radio, new realms of pleasure and utility, once locked to all but the professional, now swung wide open to everyone, however unfamiliar with radio by the marvelous proficiency and easy operation of this super-set.

Balanced Jack-knife Bridge Detroit.

The Eagle
Balanced Neutrodyne
RADIO RECEIVER

The uncertain element—tube capacities—balanced (neutralized) as perfectly as the jack-knife bridge, removes the guess from radio reception. *Gone for good* are the familiar annoyances—regeneration, reradiation and body capacity effects. Extremely sharp tuning and a perfect ease of adjustment. Each *Eagle Neutrodyne Receiver* individually tested. A splendid reputation staked on each *Eagle Receiver*. Guaranteed absolutely without reservation.

Write for Illustrated Booklet NOW!

WE SOAR ABOVE
EAGLE RADIO COMPANY
NEWARK NEW JERSEY

18 Boyden Pl., Newark, N. J.

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tough!

The radio-advantages of Bakelite-Dilecto (xx grade) are unequaled by any other material. It is positively perfect for the purpose.

bakelite-dilecto!

(A Laminated Phenolic Condensation Material)

Use B D X X for panels, frames, bases, bushings, platform mountings, coil winding tubes, variable condenser ends and other vital radio parts.

It gives absolute insulation. Resists water, heat, milder acids, fumes and solvents. Amazingly tough, yet readily machined. Won't warp. *Highest* dielectric strength. Any electrical man can get it cut and drilled for you. Insist on B D X X.

THE CONTINENTAL FIBRE CO.
Factory: Newark, Delaware

Dealer Service from:
New York, 233 Broadway
Pittsburgh, 301 Fifth Ave.
Chicago, 332 S. Michigan Ave.
San Francisco, 75 Fremont St.
Los Angeles, 411 S. Main St.
Seattle, 1041 Sixth Ave., S.

HOWARD

HOWARD

No. 1001
6¼ Ohm Rheostat..... $1.10
25 Ohm Rheostat..... 1.10
40 Ohm Rheostat..... 1.10
Patd. 870,042

Ask the man to show you the **Howard** line of quality Radio Merchandise. Every piece is sold with the **guarantee** of **satisfactory** performance.

Jobbers write for discounts.

HOWARD

No. 1002
6¼ Ohm Micrometer Rheostat..... $1.50
25 Ohm Micrometer Rheostat..... 1.50
40 Ohm Micrometer Rheostat..... 1.50
Patd. July 10, 1923

HOWARD

No. 1003
200 Ohm Potentiometer.$1.50
400 Ohm Potentiometer .2.00
Patd. 870,042

HOWARD

No. 1004
Multi Terminal Receiver Plug, instantaneous connection for as many as six pairs of standard receiver tips..... $2.00
Patd. Aug. 28, 1923

HOWARD RADIO CO., Inc.
4248 North Western Ave., Chicago, U. S. A.

SCHINDLER'S

BUILD-UP

50c to 75c

MICA CONDENSER

Schindler's "Build-Up" Condensers fill a definite need for reasonably priced condensers that may be easily increased or decreased in capacity.

By the use of a "Build-Up" Mica Condenser you can change from an ordinary phone condenser to a special .006 value used in the Flewelling Circuit.

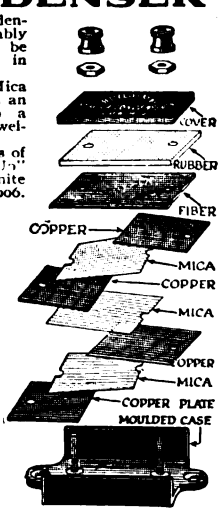
By simply adding extra plates of mica and copper to the "Build-Up" base, you can obtain any definite capacity from .00025 to .006. (Each mica plate with the alternate copper plate has a capacity of about .002 Mfd.)

"Build-Up" Condensers are dilation proof. They insure high efficiency and will add satisfaction to the operation of any set. Each assembled complete in neat carton. Prices:

Mfd.	List Price	Mfd.	List Price
.00025	50c	.0025	65c
.0006	50c	.005	70c
.001	55c	.006	75c
.002	60c		

Extra envelope containing 20 mica and 20 copper plates, or sufficient to build up a condenser from .00025 to .006 list price 25c. Table showing required number of plates for any capacity is furnished with each condenser.

Ask your dealer or order direct.



Patent Pending

CHARLES SCHINDLER
1405 West Delaware Avenue
TOLEDO, OHIO

HEAR HERE

100% with the PREMIER

"Microstat"

Trade Mark

Super Vernier RHEOSTAT

$3.00 AND WORTH IT

THERE is no substitute for the Premier "Microstat"—no other instrument that gives such perfect control of the current delivered to the filament of radio tubes. New principle—two windings in parallel—one 6 ohm—other 40 ohm. Absolutely noiseless—infinite control—handles any tube. Cap. 3 Amp. Bakelite moulded—silver etched dial. Do not install a Rheostat until you know all about the "Microstat." Our bulletin No. 97 explains it in detail. Send for it. It's FREE.

Premier Electric Company

3807 Ravenswood Ave. CHICAGO

Ask your Dealer for PREMIER "MICROSTAT"
TRADE MARK

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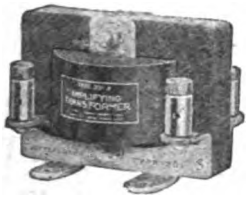
SUCCESSFUL AMPLIFICATION

Successful audio frequency amplification is not alone a question of tubes and transformers, but rather one of a careful choice of all parts entering into the amplifying circuit.

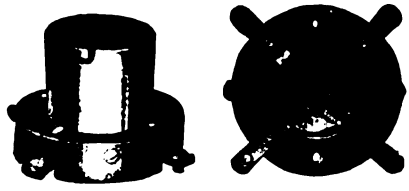


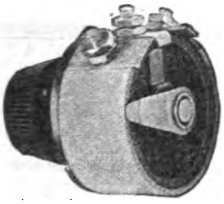
The transformer is of first importance. Little need be said nowadays of the necessity of freedom from distortion as this has been so well emphasized that purchasers today will accept only transformers of proven quality. Let us call your attention again to the fact that the General Radio Co. was the first company to supply commercially closed core audio frequency amplifying transformers. The quality of these transformers has been synonymous with successful amplification.

TYPE 231A AMPLIFYING TRANSFORMER, $5.00

Socket springs must make a clean gripping contact with the vacuum tube prongs. Many disturbing noises may be introduced by a poorly designed socket. The Type 156 socket has positive contact springs, a base of real bakelite, and a polished nickel tube. It cannot help giving satisfaction.

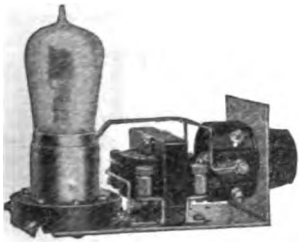
TYPE 156 SOCKET, $1.00





The resistance wire of the Type 301 rheostat is firmly wound on a specially treated fibre strip. The contact arm runs smooth and makes a clean positive contact. The base is of real bakelite. This rheostat is strictly a quality product.

TYPE 301 30 OHM RHEOSTAT, $1.25



In this unit there are combined the three successful instruments listed above. The result is an amplifier unit representing the best in quality, yet at a price within the reach of all.

TYPE 300D AMPLIFIER UNIT, $8.25

TYPE 300C AMPLIFIER UNIT FOR UV199 TUBES, $7.75

Send for FREE RADIO BULLETIN 916U

GENERAL RADIO COMPANY

Massachusetts Avenue and Windsor Street

CAMBRIDGE 39 MASSACHUSETTS

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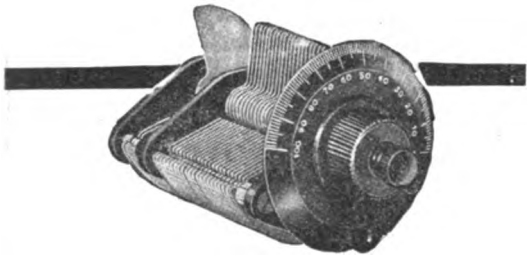


U. S. TOOL CONDENSERS

OXIDIZING of ordinary plates and spacers, creates a high resistance to the weak radio frequency currents. U. S. Tool Condensers are protected from this deterioration by a special counter-chemical treatment. End plates of Laminated Condensite-Celeron. Reasons for the persistent efficiency of *U. S. Tool Condensers*. Unconditionally guaranteed. Write for booklet.

U.S. TOOL COMPANY INC. *116 Mechanic St Newark, N.J.*

NOTHING IS WORTH WHILE UNLESS IT IS "RELIABLE"

Tune In On The Station You Want With Dependable Results

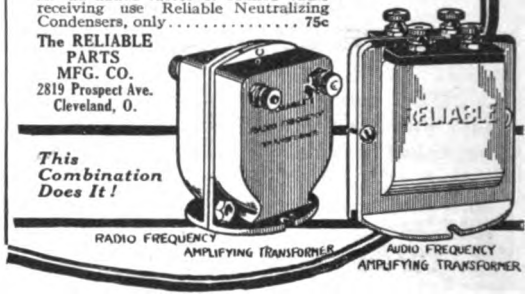
Are you master of your radio set or do you simply trust to luck in getting distant stations? You can get both distance and volume with

RELIABLE AUDIO and RADIO FREQUENCY TRANSFORMERS

Three stages of Audio Transformers to select from.
2 to 1 and 4 to 1 ratios at..... $4.45
6 to 1 ratio at..... 4.95
Radio types from 150 to 750 meter ranges.... 2.75

As an added factor of refined radio receiving use Reliable Neutralizing Condensers, only..... 75c

The RELIABLE PARTS MFG. CO.
2819 Prospect Ave.
Cleveland, O.



This Combination Does It!

RADIO FREQUENCY AMPLIFYING TRANSFORMER

AUDIO FREQUENCY AMPLIFYING TRANSFORMER

"EVERYTONE"

(Guaranteed)

RADIO HEADSET

$3.50 2200 OHMS

3000 Ohms $3.75

A BETTER headset at a lower price. Advanced features assure clear reception and long, satisfactory service. Send for Catalog P-1 of Pacent Radio Essentials.

Pacent Electric Co., Inc.
22 Park Place, New York

Pacent
RADIO ESSENTIALS

THE MOVING FINGER—

Just as the Moving Finger writes never to return, so the undetected radio waves slip by your set, gone forever; while the set is all too often "damned with faint praise" because it fails to operate properly.

PERHAPS it's your set; *and perhaps it's YOUR fault.* An adjustable grid-leak can do much to assure both the distance and clarity you seek. The

TURN-IT *adjustable* GRID-LEAK

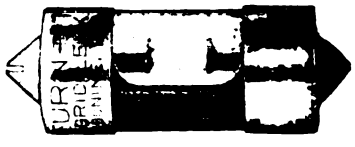
is just what you need; fits all standard mounts, gives instant response and always the exact value you seek for your tube, circuit and signal.

The TURN-IT Grid-Leak is now being sold in ever increasing quantities by practically every worth while dealer. It is priced right; is in active demand and is a perfect piece of radio mechanism. If not sold by your dealer, you can purchase it direct from the manufacturer.

CHARLES E. BONINE
20 So. 15th Street
Philadelphia

75c. (Postpaid)

If ordered C.O.D. 10c extra



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"BUILD YOUR OWN" WITH "RASCO" PARTS!

THE Radio Specialty Company—"RASCO" for short—now in its third year, is unquestionably the oldest and most unique radio parts supply house in the United States, if not in the whole world. This Company makes a specialty of small orders. No order is too small to get immediate and prompt attention. The reason is simple: 80% of our orders are small.

The reputation of this house was built upon service. Ask any of your radio acquaintances what they think of "RASCO" service, "RASCO" promptness. Thousands of unsolicited testimonials are in our files to prove that we serve the public as it has never been served in radio merchandise before. Be sure to get our great 84-page catalog, containing over 500 different parts. Catalog contains over 300 illustrations. "WE CAN ONLY DISAPPOINT YOU ONCE." Try us with a 50c. order and make us prove what we say. Prices include delivery to your door

Order direct from this page. We pay all transportation charges. All goods sent prepaid in 24 hours.

NOTE BIG PRICE REDUCTIONS THIS MONTH **Money refunded if goods do not satisfy**

LOOP AERIAL
The loop aerial you have been waiting for. Made entirely of well seasoned hard wood. Complete with all parts necessary. Has concealed wire wind. Total length of loop, 32". Base, 8 feet 6 inches long; 10 connections. Can be put together by anyone in less than 5 minutes. Satisfaction guaranteed.
R-3000. The best loop aerial, complete $6.15

STORAGE BATTERIES
Rasco Rasco Rasco
Two volt, 60 ampere hour storage battery for use with WD11, 12, and U.V. 201 tubes. Don't keep on buying dry cells continuously. This storage battery will pay for itself in two months. Only the materials used. Guaranteed for 2 years. You can connect up to 6 dry cells in a single unit of these batteries. Can be recharged for a few cents. Hard rubber container encased in incorporated wood case. Due to the price and large weight of batteries, parcel express collect.
R-3000. Two volt, 40 ampere hour storage battery, size 3¼x13x9" $4.25
R-3001. Six volt, 40 ampere hour storage battery, size 6¾x13¼x9" 8.75
R-3002. Six volt, 60 ampere hour storage battery, size 8¾x9¾ 11.00

RADIO CABINETS
Highest grade mahogany cabinets made. Rich hand rubbed finish. Top is hinged. Front of cabinet is hinged to fit panel. Prices delivered to your door; no panel included at these prices. Entire cabinet made of ¾" well seasoned stock.
R-3704. Wood cabinets, panel size 7"x14" $3.35
R-3705. Wood cabinets, panel size 7"x16" 3.60
R-3706. Wood cabinets, panel size 7"x18" 3.40
R-3707. Wood cabinets, panel size 7"x10" 2.60
R-3712. Wood cabinets, panel size 7"x12" 3.00
R-3711. Wood cabinets, panel size 7"x21" 3.90

CARDBOARD TUBING
Only seamless tubing made in United States. Perfectly concentric wall. (I.D.—Inside Diameter. O.D.—Outside Diameter. L.—Length).
R-3000. 2" I.D., 2¼" O.D. x 7" L. ..... $.30
R-3001. 2⅛" I.D., 2⅜" O.D. x 7" L. ..... .35
R-3002. 2⅜" I.D., 2⅝" O.D. x 7" L. ..... .25
R-3003. 3⅜" I.D., 4" O.D. x 7" L. ..... .35
R-3004. 4" I.D., 4¼" O.D. x 7" L. ..... .35
R-3005. 5⅜" I.D., 5⅝" O.D. x 7" L. ..... .15

"RASCO" BEZELS
The finest Bezel on the market. Best brass made stock. The Bezel comes entirely nickle plated. Will improve looks of your panel 100 per cent. Inside diameter 1". Can be used on ⅛" or 3-16" panel.
R-1700. Bezel ..... $.15
R-1701. Bezel 1⅛" diam. ..... .20

FORMICA PANELS
Cut to Size.
This shorting is definitely the best made on the market. Finish on both sides. The well known to require much explaining. Due to the fact that we are distributing these particular sizes, this material is now offered practically at cost. Prices are about 60 per cent lower than our catalogue list. Please note that prices include parcels prepaid. The size amounts to a considerable saving.
R-3000. 6"x12"x3-16" thick, each $1.10
R-3001. 9"x12"x3-16" thick, each 1.75
R-3002. 12"x18"x3-16" thick, each 4.00
R-3004. 6¼"x19⅝"x3-16" thick, each 1.50
R-3005. 6"x12"x1-16" thick, each 1.00
R-3006. 6"x9"x3-16" thick, each ..... .70

RADIO MISCELLANEOUS
The Coupler while extremely low in price is able to do anything and everything that the more expensive ones accomplish. Silk Wire wound on bakelite tubes. There are six taps on the tube. Wave length of Coupler is from ¼" short. Your money refunded if it does not do all that we claim for it.
Coupler, prepaid $1.30

MELOTONE LOUD SPEAKER
The best popular loud speaker on the market. Has tuned feature the same as all "Rico" phones. Fibre horn, heavy metal base, five foot cord. Nickle gooseneck. Greatest tuned loud talker. Compares favorably with most expensive speakers. Size overall 14¼": horn length 11¾"; bell 6¾"; total height 9".
R-235. Melotone Speaker $4.90

RICO TUNED RECEIVERS
No better phones made. Supervenitive. Amended Radio News Laboratories Certificate of Merit. The only tuned phone on the market. Can be tuned for any intensity and sensitivity. Magnetic pole pieces in mathematical center of diaphragm. Turn the cap to tune."
R-2020. 2000 ohms, double head set $4.65
R-3030. 3000 ohms, double head set $5.30
TO TUNE

"RASCO" VERNIER
Cleverest vernier made Can be used with any dial Soft rubber ring engages dial Does away with vernier condenser. We guarantee results. All metal parts moulded in best black composition. Nothing to come apart. Biggest hit of the season.
R-1450. Vernier ..... $.30

"RASCO" POSTS
R-650. Post made entirely of best black composition—8/32" thread ..... $.08
R-202. Post has nickel-plated bottom part, each ..... .08
Dozen, each style ..... .90
650 202

"RASCO" SWITCH POINTS
Nickel-plated and polished. The following have been found the most popular
R-301. "¼" 6/32" thread, doz. ..... $.10
R-302. 3/16" high, ¼" dia., 6/32" thread doz. ..... .10
R-303. 3/16"x3/16", 4-36" thread, doz. ..... .10
R-304. ¼" dia., ⅜" thick, shank 6/32" doz. ..... .10
R-305. ⅜" dia., 3/16" thick, shank 4/36", doz. ..... .10
R-306. 3/16" dia., 3/16" thick, shank 4/36 doz. ..... .10
R-307. 3/16" dia., ¼" thick, shank 4/36, doz. ..... .10
R-308. Switch Stop, ⅜" long, 4/36 thread, complete with nut, each ..... .10
301 302 303 304 305 306 307
375

"RASCO" SOCKETTES
Substitute for Vacuum Tube Socket Four of these take one Vacuum Tube Grasp tube firmly. Best contact possible Take less room. Are better.
R-1550. Sockettes, nickeled, set of 4 ..... $.25
R-1551 Sockettes, nickeled, set of 4 (to take WD-11 Tube) ..... .25
Note: Set of 4 sufficient to hold 1 Tube

COPPER FOIL
Thinnest copper foil made, .001" thick. Comes 4" wide.
R-3025. Copper Foil, per ft. $.10
10-FT. length ..... .80

PHONEHORN
Fills a new and distinct want. Base consists of R-1310 Phonedapter described on this page into which fits a fine enameled fibre horn. Size of horn 12"; bell 6¾". Slip Phonedapter end on a single telephone receiver and you have the lowest priced loud talker ever made. Mounted in your set or hung in corner of room it will bring sound all over the room. A most useful article. Welcome by all radio fans. R-1321 Phonehorn, prepaid $1.45

AUDIO FREQUENCY TRANSFORMERS
No better Transformer on the market. Highest class materials. Impregnated coils. Silicon steel stampings used. Save 50 per cent by assembling it yourself.
R-1100. A.F. Transformer, ratio 4¼ to 1 ..... $2.00
R-1150. A.F. Transformer, ratio 6¾ to 1 ..... $2.00

RADIO FREQUENCY TRANSFORMERS
The best Radio Frequency Transformer developed so far. Designed for us by Mr. R. E. Lacault, Associate Editor of RADIO NEWS. Air core. Guaranteed to do the work. This Transformer brings in the long distances.
R-2000 Radio Frequency Transformer, size 1⅞"x2¼" $1.50

RHEOSTATS AND POTENTIOMETERS
Highest grade Rheostat made. High heat dielectric composition base. Wound with best non-corrosive resistance wire. Comes with tapered, knurled knob. Diameter, 2¼". Complete with pointer.
R-4340—6 ohm, each $.45
R-4311—30 ohms, for 301a and 201a tubes, each ..... $.65
R-4312—Potentiometer, 200 Ohms each ..... $.85
JUST OUT Cat. No. 10

SPIDER WEB FORMS
At last! Fine forms to wind your spider webs. Made from hard, well seasoned fibre. 1-16" thick, center and side holes for wiring. 3200 has 12 slots, 3201, 11 slots, both 5" diameter. 3201 has projection for mounting
R-3200—Spider web form, each ..... $.25
R-3201—Spider web form, each ..... $.25
3200 3201

BRASS RODS
Sold in 6" lengths only
R-8032. Brass Rod, 8/32" thread, per length ..... $.06
R-6032. Brass Rod, 6/32" thread, per length ..... .06
R-1425. Brass Rod, plain ¼" round, per length ..... .10
R-3618. Brass Rod, plain 3/16" round, per length ..... .06

"RASCO" NAME PLATES
The circular shows 15 new Binding Post Name Plate. Diameter, ⅞". These terminations: PHONES—GROUND, — OUTPUT, "A"—BATTERY —, "B" BATTERY —, LOUD SPEAKER, GRID, LOAD "C" BATTERY—, AERIAL +, INPUT, "A" BATTERY + "B" BATT +, LOOP, TICKLER, PLATE, "C" BATT +, FILAMENT.
R-6000 to 6019. Binding Post Name Plates, each denomination ..... $.01
Dozen ..... .30

REINARTZ SPIDERWEB COIL
Here is a very fine inductance for Reinartz circuit, 200-600 meters. 10 taps. Size 4¾" diameter; 1¾" center opening. Can be used in nearly all new circuits Construction shoulder-nets throughout. Coil is firm and will not fall apart as is case with many inferior makes. A few of these coils will suit your set. Try one in your set.
P-2850 Spider-web Reinartz coil $1.15

PHONODAPTER
The Phonodapter will fit any phone. Metal tube fits any standard phonograph. Make your phonograph a loud talker. Fits Columbia, Victor and Sonora phonographs. Is made entirely of pure soft rubber with brass tube inserted.
R-1310 Phonodapter ..... $ .90

DOUBLE PHONODAPTER
The Double Phonodapter fits all phonographs and will take any standard double head set, thereby making your phonograph a loud talker. Made of cast metal, nickel plated and highly polished. Has three generous soft rubber bushings.
R-1320 Double Phonodapter ..... $ .60

PLUGS
RASCO Telephone Plug.
This is the plug that is sold from 35c to $1.00 everywhere. Has hard rubber composition shell and patented cord tip holder. Must be seen to be appreciated. Finest workmanship throughout.
R-1030—Rasco Telephone Plug, each ..... $.35

LITZ WIRE
R-323, equals No. 25 B&S, per foot ..... $.02
R-890, equals No. 28 B&S, per foot ..... .01
R-891, equals No. 21 B&S, per foot ..... .03
R-892, equals No. 20 B&S per foot ..... .04
Discounts of 10 percent in 100-ft. lots.

UNIVERSAL BEARING
THE bearing to hold variometer and variometer rotors. Total length of bearing 2¾". Outside shaft, 1¼". Length of thread 1". Length of threaded sleeve, ¾".
R-1375. Bearing ..... $.25

PANEL MOUNTING VARIABLE CONDENSERS
This condenser presents the latest word in precision mechanics. Plates, washers, and all other parts are accurately machined. Positively no better condenser on the market. Shafts ¼". Save from 40% to 60% by assembling condenser yourself. A child can do it in a few minutes spare time. Capacities guaranteed.
R-1111 11 plate condenser, .0002 mfd. $1.10
R-2121 21 plate condenser, .000 mfd. 1.22
R-4343 43 plate condenser, .001 mfd. 1.50

The "Rasco" Catalog
CONTAINS 75 VACUUM TUBE HOOK-UPS. 350 ILLUSTRATIONS 350 ARTICLES. 84 PAGES **No. 10**
All Armstrong Circuits. These important circuits explained clearly, all values having been given leaving no doubt as to what could puzzle you.
Just to name a few of the Vacuum Tube circuits. The V T as a detector and one-step amplifier; Armstrong circuits, one step radio frequency amplifier and detector, three stage audio frequency amplifier; short wave regenerative circuits; 4-stage radio frequency amplifiers, radio and audio frequency amplifier; Inductively coupled amplifier; Armstrong supersutodyne, etc.
SENT ANYWHERE **FREE**

Radio Specialty Co.
96A Park Place - New York City
Oldest and Original Exclusive Radio Parts House in U. S.
Factories: Brooklyn, N. Y. Elkridge, Md.

DEALERS
Get Our Special Proposition

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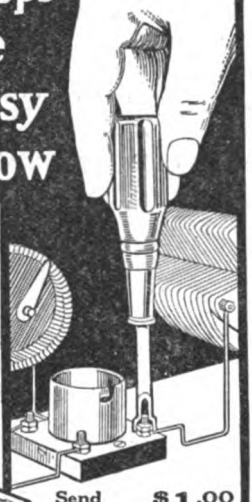
New Hook-Ups Are Easy Now

You'll save hours of labor and make connections as solid as soldering with

Stevens Spintite Wrenches

Hollow stem goes down over projecting screws—hex socket gets firm grip—ebonized handle for comfortable leverage—very easy to reach difficult places. Used by radio manufacturers.

Set makes happy Christmas gift



Send for set of 3 radio sizes **$1.00**

STEVENS & COMPANY
377 Broadway, New York

Stevens SPEED UP Tools

FOUR CIRCUIT COIL SET

$2.50

"A" Coil covered square wire.

"D" Coil bank wound.

Full set A, B, C and D coils made exactly according to Cockaday's specifications. Full size blue prints and illustrated instructions with each set.

Materials for standard Four Circuit Tuner—panel, coils, condensers, verniers, grid leak, vernier rheostat, socket, jack, dials, switch, contacts, posts, busbar wire, spaghetti, etc. (no tubes or phones).

Complete for $11.65

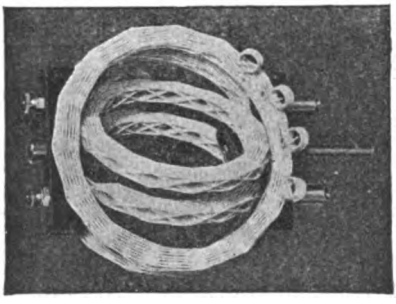
NEW TYPE COILS

For improved Cockaday Tuner—double silk covered wire wound on hard rubber or bakelite tubes. **$4.00** per set

Postage additional on all orders

Send no money. Order by post card, pay the postman.

RADIO SURPLUS STORES
HELENA, MONTANA



Diamond Weave Variocoupler
An R. M. C. Product

Seven-eighths of windings are in mid-air, thus reducing dielectric losses to a minimum.

Diamond Weave Construction reduces distributed capacity to a minimum.

The R. M. C. Variocoupler has a wave range of 150 to 600 meters. The Variometer is the same size and general construction as the variocoupler, and has a variance in inductance of 300 meters.

Outside diameter of primary windings is 4⅛"; of secondary, 3¼"; extreme length 5¼".

These R. M. C. products will greatly improve any circuit where a variometer or variocoupler can be used.

Variocoupler.....$4.50
Variometer.....$4.50

THE RADIO MANUFACTURING COMPANY
of Springfield, Massachusetts
Dept. B **97 Dwight Street**

LEICH
RADIO PRODUCTS

Non-Tune Radio Rectifier

Simple to operate. Needs no attention while charging. Automatically cuts off and on if power stops.

No. 16 for 6 volt battery, $19.00.

No. 10 for charging storage "B" Batteries, $12.00.

LEICH COMFORTABLE HEADPHONES

Clear tone, perfect fitting, most comfortable to wear. Bring in voice or music with volume. Natural and pleasing.

L'-Radio Plug

for connecting headphones or loud speaker. Sturdy—nicely finished.

No. 60 Single Phone, 90c.

No. 61 Two Phones series, $1.00.

Ask your dealer to show you Leich Radio Products. Booklet 101-L illustrating complete line on request.

LEICH ELECTRIC CO.
Genoa, Illinois

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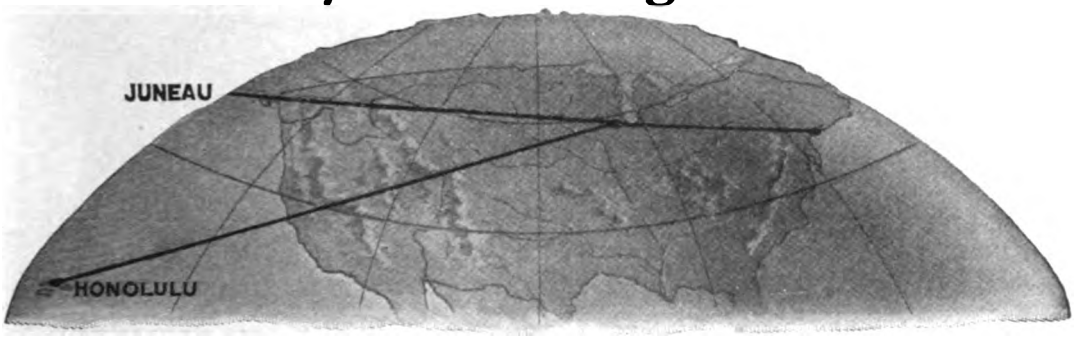
From New York to Honolulu
With Erla Synchronizing Transformers



Unequaled range and power, over a waveband of 200 to 700 meters, is assured by Erla synchronizing reflex transformers. List, $5 each

Solve crystal troubles by installing an Erla fixed crystal rectifier. Once installed, no attention is required. Jolt and jar proof. List price, $1

Erla is the only condenser guaranteed to test to the exact capacity for which it is marked. Made in eleven sizes, 30c to 75c each

"All U. S. Stations on Loud Speaker, Using Only Three Tubes"

Typical of the thousands who have discarded complicated multi-stage receiving units in favor of simple, efficient Erla reflex design, is the experience of J. G. Hamock, 1917 So. Western Avenue, Chicago, who writes:

"During my first week with your three-tube hook-up, tuning through high power Chicago stations, I got Jefferson City, Dallas, Memphis, Atlanta, Omaha, Kansas City, St. Louis, New York, Springfield, Pittsburg, Harrisburg, Louisville, Cincinnati, Fort Worth and Tampa.

"The Sunday following I added Fresno, Denver, Astoria, Los Angeles; Honolulu, Hawaii Naval Maneuvers; and Juneau, Alaska, the Alaska Electric Light and Power Co.

"The United States Stations all were clear on the loud speaker. Also I re-tuned every station by checking them with my twelve-year old son, who would get them on the re-tune, when I would, as required, sharpen the re-tune myself."

Such power, selectivity and ease of control, with three tubes, are attainable only through Erla reflex design, incorporating Erla synchronizing r. f. and a. f. transformers.

Guaranteeing the perfect synchronization of received and reflexed currents having the same phase characteristics, Erla transformers enable vacuum tubes to do triple duty as simultaneous amplifiers of received radio frequency, reflexed radio frequency and reflexed audio frequency currents.

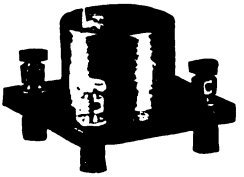
For complete details, ask your dealer for Erla Bulletin No. 14, giving Erla one, two and three-tube reflex hook-ups. Or write direct, giving your dealer's name.

Electrical Research Laboratories
Dept. R 2515 Michigan Avenue' Chicago

ERLA

Unduplicated amplification without distortion enables Erla audio transformers to improve any receiving unit. Ratios: 3½ and 6 to 1. $5

Attractive Erla telescoping bezels, in bright nickel or dull black enamel, fit any ⅛" to ¼" panel. Made in 1" and 1½" diameter. List, 20c



Mechanically and artistically, Erla sockets occupy first place. Heavy, triple nickeled shell on polished Radion base. List price, $1

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Stations brought in from over 1000 miles and music heard all over the room right from your present crystal set with the STEINMETZ AMPLIFYER. Get our complete catalog.

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The Audio-Frequency Transformer that gives the highest possible amplification on all wave lengths without the slightest loss of tone quality and volume

The F.M.C. SUPERTRAN can be used with any amplifying tube on the market to-day with excellent results.

Price $6.00

At your dealers or by mail postpaid on receipt of purchase price. Write for our free literature.

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14 Christopher St. New York

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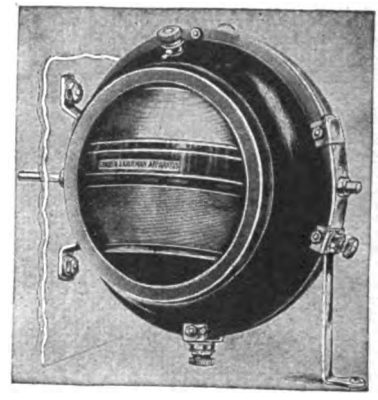

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UNIVERSAL VARIOMETER
—SPLIT WINDINGS—

The instrument you will NEVER DISCARD for its uses are without number. **List $7.00.**
L & K moulded HARD RUBBER variometers, variocouplers and variotransformers are made in seven styles, an instrument for every standard circuit.

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654 Grand Ave., NEW HAVEN, CONN.

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TRADE Wave Trap MARK
PATENT APPLIED FOR

The *Original* Wave Filter

Stops Interference!

Eliminates interfering stations.
Improves the selectivity of the set.
Eliminates local broadcasting.
Selects between conflicting stations.
Simplifies tuning.
Often increases signal strength.
Reduces howling and squealing.

The WAVE TRAP is mounted on a Formica panel in a beautiful mahogany finished cabinet 6x5x6, and is a high-grade instrument throughout enhancing the appearance of the most expensive sets.

8.50 CHARGES PREPAID

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The highest tonal quality undisturbed by either metallic noises or distortion is best obtainable with a fiber horn. This one factor is the reason for Fibertone's popularity. And the low price for such fineness is a sensation of the radio world. The beautiful crystalline finish of the Fibertone fits it for any place where the finer things of the home are seen.

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FIBERTONE
RADIO HORN

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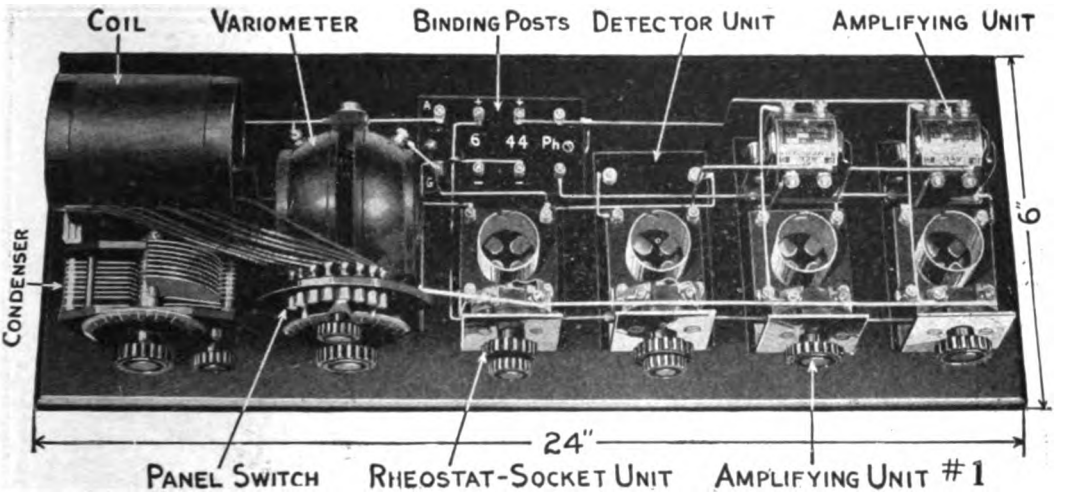

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1 Stage Radio-frequency—2 Stages Audio-frequency
Built on Famous Copp Circuit No. 4
Efficient for all wave-lengths from 200 to 700 meters
Range up to 2000 miles

Any person can build the above set with A-C DAYTON Complete Units

$43.35

Units packed complete in one carton with wiring diagrams, photographs, instructions, etc., for complete installation.

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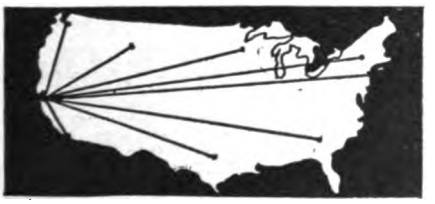
Makers of Electrical Devices for over 20 Years.



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Broadcasting from Atlantic Coast, Canada, Mexico, Cuba & Hawaii heard in Calif. by users of the CROSS COUNTRY CIRCUIT. Range due to simplicity. One tuning control. ANY NOVICE can build easily and cheaply. Dry cell tubes used. No soldering. Complete instructions, Blue print panel layout, Assembly Photo, etc., postpaid 25 cents. Stamps accepted.

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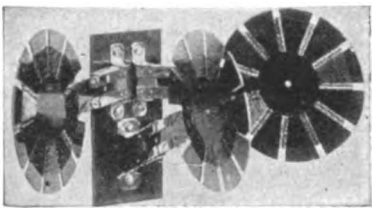

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The GOODMAN is the niftiest short wave tuner on the market. Awarded certificates of merit. Our pamphlet tells all about it. Send for one. Price $6 and PP. on one pound.

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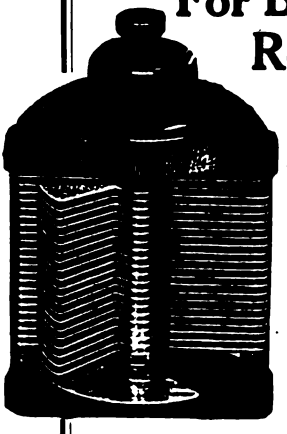
For Better Receiving



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Accuracy in your condensers means better results in your receiving. Elgin Precision Condensers are accurate. Permanent accuracy and rigidity are built into them.

Fully Guaranteed

Size	Capacity	Plain	Vernier
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11 Plate	.00025 M. F.	2.40	4.00
17 Plate	.00035 M. F.	2.75	———
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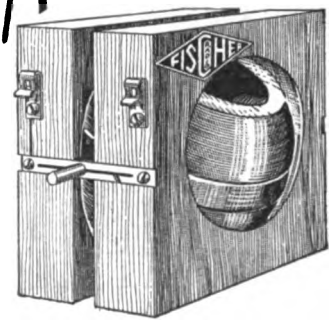
3" diameter composition dials, 50c extra

See your local dealer. If he cannot supply you send his name with your order to

The Elgin Tool Works, Inc.
69 N. State St., Elgin, Illinois

Approved!



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GET ONE FOR $3.50
20 Diagrams FREE with Each

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Cut ¾ actual size

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PREMIER Audio-Frequency Transformer

HERE you have it—the smallest Audio-Transformer ever made, and yet the most efficient for volume and tone quality. Think of it! This "Little Wonder" (about the size of an English walnut) gives you maximum reproduction volume with minimum distortion. The secret is in its patented construction. It is 100% shielded against foreign noises. Mounts anywhere—saves space in assembly. Constructed of highest quality material. Made in tube socket types also. We guarantee it unconditionally. Try them in your next "hook-up." You'll be agreeably surprised and pleased.

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1 to 3, 1 to 4, 1 to 5, $3.50 1 to 10, $4.50

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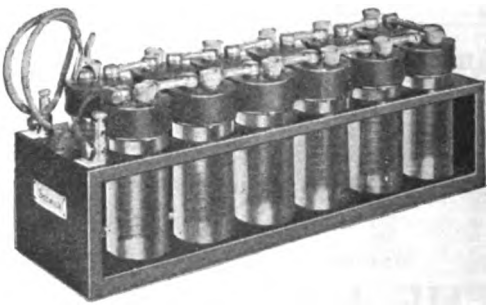
3807 Ravenswood Ave. CHICAGO

Ask for and insist on Premier at Your Dealers



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Absolutely Quiet *Dry* Charged

The Seneca 24 Volt Radio B Battery is designed and constructed for *long life, absolutely quiet and uninterrupted service*, its separate cell assembly prevents current leakage common to other types. Seneca Batteries are shipped DRY with FULLY CHARGED PLATES and are ready for service immediately after addition of acid, without initial charging. They guarantee successful RADIO OPERATION. Send for yours today, if not satisfactory, return in 30 Days and money refunded.

For those who wish to build their own B battery we offer Genuine Seneca Battery Parts at 50c per cell, consisting of one each Pos. and Neg. DRY CHARGED plates, one Separator, one Glass Jar, one Cover with Gasket and Vent, and one Cell Connector. Shipped via P. P. prepaid upon receipt of price.

SENECA BATTERY CORPORATION
1525 Main Street - - Buffalo, N. Y.

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Press the button—the set is quiet. Pull, and the same program is resumed.

Disconnecting a battery lead is one way of shutting off a radio set, but many tubes and batteries have been ruined by putting it back on the wrong post. A C-H Radio Switch costs 60c—if you save only a few dry cells it quickly earns the cost.

The C-H Engineers designed this radio switch mechanism so that the contact member floats, independent of the button. Touching it, or jarring the table does not cause noise in the phones.

The large capacity and easy mounting make it ideal for any use in radio.

Can You Interrupt Reception Without Losing the Station Received?

This Little Switch Can Be Installed in a Few Minutes to Give Hours of Increased Pleasure

With the C-H Radio Switch on your panel in the "A" battery circuit, just a touch of the nickeled button and the set is quiet—pull it out and the same program is resumed. It is not necessary to turn back the rheostats and disturb the tuning of the set. You have instant, positive control with a real switch mechanism designed by the C-H Engineers to break up to 3 amperes at 110 volts, yet so precise that no microphonic noises are introduced, even when used in the most delicate circuits.

The cost of this little convenient necessity is only 60c, and it can be mounted on any panel in a few minutes to protect tubes and batteries worth many dollars. It is installed by drilling only a single 7/16" hole, and can be used for the control of practically any radio circuits.

The bright orange and blue boxes with the C-H trademark designate the genuine. Dealers everywhere are featuring them. If yours has not yet been stocked, send 60c plus 10c for packing and mailing, and you will be supplied direct very promptly.

THE CUTLER-HAMMER MFG. CO.

Member Radio Section, Associated Manufacturers of Electrical Supplies

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C-H RADIO SWITCH

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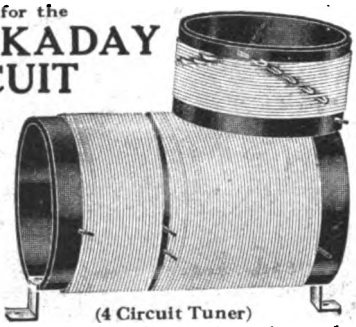
EASTERN COIL SETS

for the

COCKADAY CIRCUIT



(4 Circuit Tuner)

are now a standard, and in universal use, due to their efficiency in this wonder circuit.

Made as per specifications of Mr. Cockaday, using No. 18 wire with D coil bank-wound.

COMPLETE ASSEMBLED SET OF B, C AND D COILS. $2.75

Hook-up, directions and material list furnished FREE with each set of coils.

Mail Orders Filled. Dealers Communicate.

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YOU DON'T NEED TUBES

To hear concerts from distant Cities.

YOUR CRYSTAL SET

will bring them in if you follow my instructions. You may already have all the parts you need and merely have it hooked up wrong.

People using my plans hear programs clearly from stations.

400 TO 1000 MILES AWAY

No TUBES, Batteries or AMPLIFYING Apparatus required. My COPYRIGHTED instructions selling for $1.00 are written so anyone can understand. They show you exactly how to fix the set you have or make one like mine.

Satisfaction Guaranteed or money refunded.

Picture of my set and further particulars FREE. Write me today.

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7 COMPLETE PLANS 50c

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WD-11 Hookup

FULL SIZE TEMPLATES
List of parts, diagrams, and Directions
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THE **RADIO CONSTRUCTOR**

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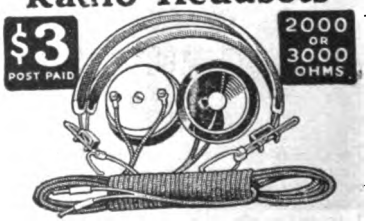
EDSON

Tone Tested Radio Headsets



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AT FACTORY PRICES

Greatest radio "B" battery on market. Full number voltage taps; QUALITY GUARANTEED; LOWEST PRICES; brings in concerts LOUDER AND STRONGER; will work on any tube or loud speaker. Order by number TODAY with check, money order or pay postman C. O. D.

No. 122B 22½ volt variable, regularly $2.25 . . . **$1.52**
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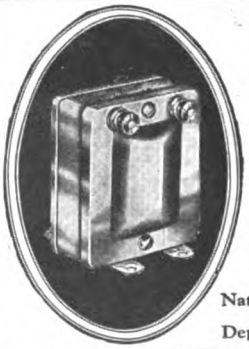

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The New 6 to 1 Ratio National Transformer is for use on the first stage of amplification. Its greater ratio means increased volume, but the tone qualities that characterize the 3½ to 1 ratio have been fully retained. Price of 6 to 1 ratio $4.50 postpaid; of the 3½ to 1 ratio, $4.00 postpaid. *Dealers: Write for interesting sales proposition.*

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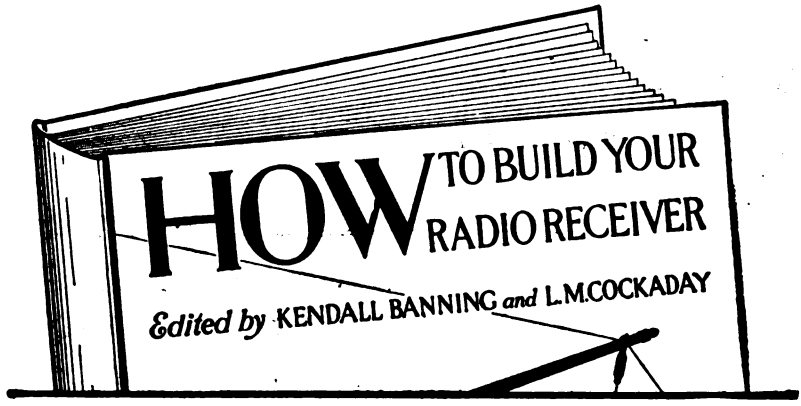

Popular Radio Announces

A New Book of Supreme Interest and Importance to Radio Enthusiasts

The most complete and authoritative collection of material yet published in book form on how to build and operate various types of radio receiving sets

THIS first announcement of a new 96-page book, edited by Kendall Banning and Laurence M. Cockaday, to be published by POPULAR RADIO, will come as a welcome surprise to our half-a-million friends and readers.

There has long been a need for such a book as this, describing fully and completely the several different types of radio receiving sets which have proved most effective, and *how to build them.*

POPULAR RADIO'S new book, "How to Build Your Radio Receiver," has been carefully planned to fill this need. No pains have been spared to make this book the most comprehensive and valuable contribution of its kind ever published for the radio enthusiast who, with or without previous technical knowledge or training, wishes to construct a radio receiving set of his own that will meet his every requirement.

"How to Build Your Radio Receiver" gives complete specifications for the construction of *seven* separate and distinct receiving sets—covering the most amazing range and variety of circuits, from the most modern simple crystal set to the famous Super-heterodyne (see opposite page).

All working details are given—the list of parts required and their approximate cost; complete hook-ups and circuit diagrams and *how to read them;* illustrations making all points clear, and simple instructions on how to assemble, mount, wire and operate each set.

Nor have any helpful pointers been omitted. In this new book edited by Mr. Banning and Mr. Cockaday, you will also find scores of valuable hints and suggestions about aerials, how to select your parts, how to install your set, tips on tuning, and how to learn the code.

In all, a book you will not want to be without—one that will be worth many dollars to you. However, no copies are for sale, as yet. The book is not yet off the press. But we want you to have one of the first copies of this new book, as soon as it comes from the press, and we want to *give* it to you *free.*

Here is our offer. For a limited time only, we will *give this book away* with a year's subscription to POPULAR RADIO at $3.00. If you are already a subscriber, you may renew or extend your subscription for an additional year and still secure one of the first copies of this valuable book *absolutely free.*

The Reservation Coupon printed at the bottom of the opposite page provides a convenient means for you to reserve one of the first copies that come from the press.

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Seven Remarkable Receiving Sets

Illustrated *Diagramed* *Described*

EACH of the sets described in POPULAR RADIO'S new book has been selected as the most *ideal* of its kind—for distance, selectivity, tone, volume, simplicity of construction, ease in tuning, reliability and general all-around satisfaction.

You will find sets employing both crystal and vacuum tube detection, with regenerative amplification, audio-frequency amplification, "push and pull" power amplification, radio-frequency, *compensated* radio-frequency and *intermediate wave* radio-frequency amplification.

You have your choice of crystal, one-tube, three-tube, five-tube, six-tube or eight-tube sets—the broadest selection anyone could ask for, all clearly illustrated, charted and explained in the simplest possible terms.

Here are the actual receiving sets described in this new book, "How to Build Your Radio Receiver":

A $5 Crystal Set

The simplest up-to-date set for local broadcast reception. Approximate range, 15 miles, though distances up to 400 miles are not extraordinary. Gives clear signals on headset without distortion. No operating cost whatever.

The Haynes Single Tube Receiver

An efficient set that may be made by a novice at an approximate cost of only $15 for parts. Simple to tune, selective, good audibility. Long distance range up to 1,000 miles on earphones. Six-volt storage battery and 22½ volt "B" battery required, or may be adapted for dry cells and dry cell tubes.

A Two-Stage Audio-Frequency Amplifier

This instrument may be added to *any* set, crystal or tube, to strengthen the received signals so that they will operate a loud speaker. It is easy to construct, efficient, and costs only about $15 for parts. Operates on the same "A" battery that is used on the vacuum-tube detector unit.

The Cockaday 4-Circuit Tuner

A 3-tube set, famous for its high selectivity and beautiful tone. So neat and compact that it may be kept in a bureau drawer. Cost of parts about $40. Receiving range approximately 1,500 miles on a loud speaker. Operates on 6 volt storage battery and two 45-volt "B" batteries, or may be adapted to dry cells and dry cell tubes.

A 5-Tube Tuned Radio Frequency Receiver

Two stages of tuned radio-frequency amplification, detector, and two stages of audio-frequency amplification are here employed so that the possibility of "oscillation and re-radiation" is eliminated. The set can be operated on a loop antenna and may be built at a cost of only $90 for parts. Six-volt storage battery and two 45-volt "B" batteries required. Range about 1,000 miles on loop or indoor antenna, and 2,500 to 3,000 miles on an outdoor antenna.

The "Improved" Cockaday 4-Circuit Tuner

Probably the most important contribution yet made to the equipment of the radio fan. A compact 5-tube set with a receiving range of over 3,000 miles. Cost of parts about $95. Wave lengths range from 150 to 675 meters. Automatic tuning and power amplification. Maximum volume of sound, excellent reproduction and no interference. Requires a 6-volt "A" battery, three 45-volt "B" batteries, one 22½-volt "B" battery and a 9-volt "C" battery.

The Regenerative Super-heterodyne Receiver

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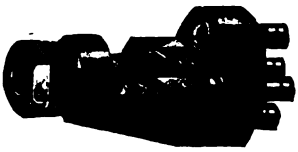

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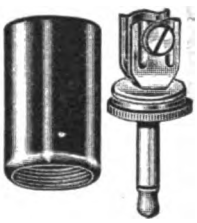

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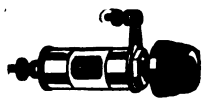

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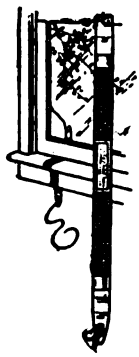

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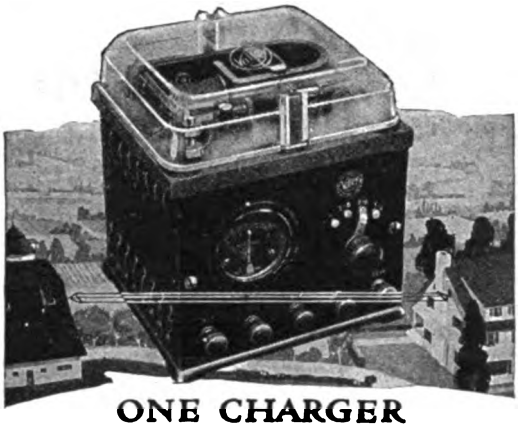

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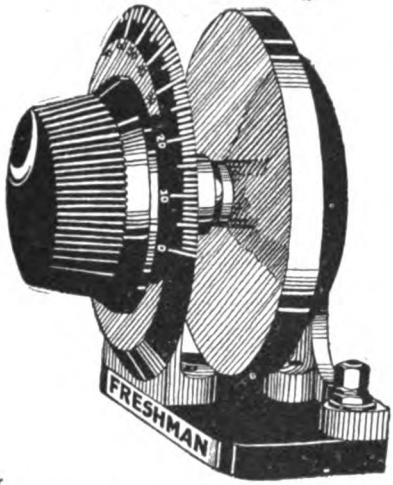

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"A" Hydrometer and "B" Battery

Read Every Word of the Special Christmas Offer—Then Act

Thousands of POPULAR RADIO Readers will profit by this amazing offer. They will buy the famous 2-year guaranteed, World battery at the lowest price ever quoted—They will get a hydrometer and a "B" Battery FREE. And they get the best battery built. It is "World" quality that makes possible our 2-year ironclad guarantee. It is "World" quality that makes "World" owners "tell their friends"—That's the best proof of performance any product can have.

Compare These Prices:

Special 200 Hour Rechargeable Storage Batteries	6 Volt 60 Amp.	$8.50
	6 Volt 80 Amp.	10.00
2 Volt for W.D. 11 and 12 tubes	6 Volt 100 Amp.	12.50
	6 Volt 120 Amp.	14.50
4 Volt for U.V. 199 tubes	6 Volt 140 Amp.	16.00
		8.00

Send No Money

You need not send a penny. Just clip this ad and attach your name and address. The battery will be shipped to you the day your order is received. When the battery arrives, inspect it—read our 2-year guarantee before you pay one penny. Convince yourself you are protected from every angle—that the World battery price saves you 50%. Get the "B" Battery and hydrometer FREE. Order today.

Special Christmas Offer

Clip and mail this ad with your World battery order and get this hydrometer and "B" battery *free*. 5% disc. for cash in full with order.

WORLD BATTERY CO.
Dept. 3, 1219 So. Wabash Ave., Chicago, Ill.

World

Radio Laboratories and Patent Offices
for the
Independent Interests

The plant of Francis H. Richards, established in 1875, equipped with separate individual laboratories, where the crude inventive idea may be developed, the experimental models tested out, and the perfected product patented, without first broadcasting the same to possible hostile third parties, has long been a boon to inventors.

To meet the present demands, the establishment is now equipped with laboratories and experienced radio mechanics and patent attorneys, to aid inventors in properly preparing their inventive ideas, either for presentation to the radio interests or to meet the keen competition which is now developing.

Francis H. Richards
9-15 Murray Street :: New York

LOUD SPEAKER $18.50

HEAD SET $4.50

"ROYALFONE"
KING OF ALL

A complete loud speaker of superior qualities. Will reproduce music or speech with no distortion.

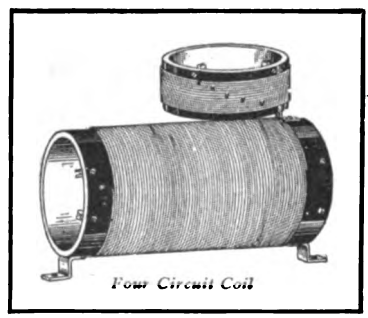
No extra batteries required. Will operate at one or more stages of amplification.

Comes complete with 6 foot cord. 24" high—14" bell—Crystaline Finish.

A highly sensitive pair of receivers for the amateur or professional — for long distance or local broadcasting, also very comfortable.

Royal Electrical Laboratories
Dept P. R., Newark, N. J.

Royalfone KING OF ALL



Four Circuit Coil

Low Losses at High Frequency

This Four Circuit Coil is made in strict accordance with Cockaday's specifications. By actual efficiency tests it is positively the most selective coil made.

Its special construction using hard rubber throughout, precision wound with double silk covered wire, give—

Perfect insulation, less leakage losses, high dielectric, greater selectivity, greater resistivity.

Write for further details. Special proposition to dealers

PRECISION COIL CO., Inc.
209 Center St., New York City

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NA-ALD

De Luxe Dials

The artistic qualities of Na-ald De Luxe dials distinguish these dials as truly beautiful. They add to the appearance of any set in which they are used. This beauty is matched by the efficiency of Na-ald dials. They are moulded of Bakelite and have patented construction.

Alden Manufacturing Company
Largest makers of Radio sockets and dials in the world
Dept. C 52 Willow St.
Springfield, Mass.

No. 3003—4
3 Inch
35c, 3 for $1.00

The BATES EAR CUSHION

No finer Christmas gift for radio fans. Supreme comfort and keener hearing. Slips over any radio phone.

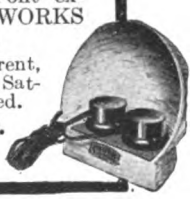
POSTPAID ANYWHERE IN U. S. $1.00

DEALERS: Write for special discounts. Fastest moving radio accessory on the market.

BATES & COMPANY
1520 Montana St. Chicago, U. S. A.

NEW PYRALIN
SHELTONE LOUD SPEAKER $3

Made by Du Pont expressly for us. WORKS with any Phones.
Beautiful, transparent, exceptional value. Satisfaction guaranteed.
THE SHELTONE CO.
185-189 Clinton Ave.
Newark, N. J.



THE NEW SIMPLEX

180° Vario-Coupler with Special Spider Web Rotor will bring in those distant stations you are trying for. An exceedingly efficient and neat coupling device which will cover all broadcast wave lengths up to 600 meters.

Price - - $3.50

SIMPLEX RADIO CO.
1013-15 Ridge Ave. Phila., Pa.

SPECIAL OFFER!

***Two* new subs. to POPULAR RADIO for only . . . . . $5.**

TAKE advantage of this Special Offer! It means a saving to you of a dollar.

You and a friend of yours may have POPULAR RADIO for a whole year, provided you are both *new* subscribers.

Just wrap your check for $5 around the double coupon and mail it to-day to save money.

Make POPULAR RADIO your New Year's Resolution and profit by all the interesting and helpful articles that are to come during 1924.

(Coupon good until January 20th, 1924)

POPULAR RADIO, Dept. 14
9 East 40th Street, New York City

Please send POPULAR RADIO for one year to:

NAME.....

ADDRESS.....

CITY.....STATE.....

And also to this other new subscriber. Here's my cash remittance— (or a check or money order for $5.00).

NAME.....

ADDRESS.....

CITY.....STATE.....

(No extra for Canada. Foreign countries 60 cents extra per subscription.)

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KEYSTONE
RADIO LIGHTNING ARRESTERS

$2.00 $2.00

Should be on every aerial the year 'round. Provides highly efficient lightning and static protection for the home. Fully approved by Fire Underwriters. Can be installed out-doors. Has no vacuum to lose. Install one in your aerial lead now—be safe.

This pioneer radio arrester is backed by 31 years experience in lightning arrester design.

For sale by Dealers everywhere, or sent post-paid for $2.00. Write for circular.

Electric Service Supplies Co.
17 & Cambria Sts.
Philadelphia

Monadnock Bldg., Chicago
50 Church St., New York

DEALERS *Send for* FREE 48 page CATALOG

Dealers who handle quality products should get our unusually attractive discounts.

All high grade standard sets and supplies
All orders shipped on day received
Write TODAY for Catalog

FEDERAL RADIO CO.
Distributors of
Standard Radio Sets and Supplies
1900 Harney St. Omaha, Nebr.

It charges them all!

HANDY CHARGER

A Battery Charger that employs no contacts that stick and give trouble, no liquids nor bulbs—yet charges 6 volt batteries at 5 to 7 amperes and also charges 12 volt batteries and from 1 to 4 "B" batteries at a time. Beautiful metal case—panel with convenient terminals for each size battery and Weston Ammeter.

If it doesn't charge 'em all, it isn't a

Handy Charger
List $18.00
Simplex model, straight 6 volt type, $16.00

Interstate Electric Company
of St. Louis, Mo.
4015 Laclede Avenue

COAST TO COAST ON ONE TUBE

E. MacDonald of Bangor, Me., received Winatchee, Wash., on 1 tube Royal Portable Broadcast receiver. One dial Control—Takes all wave lengths.

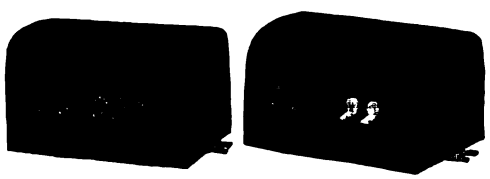
Royal Portable 1 tube set assembled	$10.00
Phones, batteries, tube-Aerial, etc., extra	9.75
2 step Amplifier to match, no tubes	17.50
Cockaday-Reinartz-Ultra Audion Circuits—Complete parts, panel, tube free with each	13.67
Autoplex circuit complete, *tube free*	18.50
5 Tube Royal Neutrodyne (Mounted) unwired	49.47
Royaltron Tubes—guaranteed Standard Base—1½ or 6 Volt, detector or Amplifier; specify which one	3.95

Write for bargain Catalog 64.

ROYAL MFG. CO.
Dep't 64 World Building, New York

Como Duplex Transformers
(PUSH-PULL)

The COMO DUPLEX SYSTEM of audio-frequency amplification gives the maximum volume without distortion and tube noise.



There is a combined filtering action which assures perfect results when ordinary amplification fails.

It can be added to your present amplifier, giving you power amplification on the weak signals that more of the ordinary amplification would kill.

SOLD IN MATCHED PAIRS
$12.50 per pair

A copy of "HOW TO MAKE A POWER AMPLIFIER" is yours for the asking.

COMO APPARATUS COMPANY, 446 Tremont Street, Boston, Mass.

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Bradleyleak

THE PERFECT GRID LEAK

AMERICAN RADIO AND RESEARCH CORPORATION
ENGINEERING DEPARTMENT
MEDFORD HILLSIDE, MASSACHUSETTS

October 25, 1923

Allen-Bradley Co.,
Milwaukee, Wisconsin

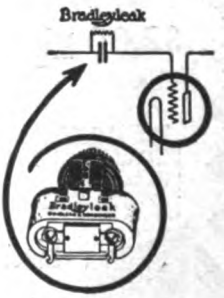
Gentlemen:

I am very pleased to report that our test with the Bradleyleak and condenser has proved it an article of considerable merit.

It is, without doubt, the best grid leak and condenser now on the market and has a greater resistance range than most variable grid leaks, now available. The capacity checked within 5%, which is very remarkable for a condenser of this type. I found the Bradleyleak remarkably free from noise.

I mounted one of the Bradleyleaks on one of our new receivers, and it is quite possible that we may incorporate it in the design.

Yours very truly,
AMERICAN RADIO & RESEARCH CORPORATION
H. J. Tyzzer
Chief Radio Engineer



Retail Price
$1.85
Condenser
.00025 MF
35¢ Extra

"The Best Grid Leak"—Says Amrad

Radio has been waiting for an adjustable grid leak which is truly adjustable and reliable. Many attempts have been made to produce such a grid leak, but with little success. It has remained for the Allen-Bradley Co., backed by 20 years' experience with compression disc rheostats, to produce an adjustable grid leak which fulfills all the requirements of a perfect grid leak. To distinguish it from all other grid leaks, it bears the name "Bradleyleak."

The Bradleyleak has been tested by such authorities in radio as Crosley, Kennedy and Amrad. They have all marveled at its noiseless, smooth control, its marvelous range from ¼ to 10 megohms and also that it is not affected by atmospheric conditions. Radio set builders are using thousands of Bradleyleaks and the demand is increasing at an astounding rate. Your detector will work better if you use the Bradleyleak. Try one on your set, today.

For Special Hook-ups the Bradleyleak is a great favorite and frequently a Bradleyleak makes an obstinate set work perfectly.

Allen-Bradley Co.
Electric Controlling Apparatus
276 Greenfield Ave.
A-B
Milwaukee, Wisconsin

Send for Bulletins and learn the proper value of grid leak resistance for the popular radio tubes. Be sure to write today.

THE ALLEN-BRADLEY CO. HAS BUILT GRAPHITE DISC RHEOSTATS FOR OVER TWENTY YEARS

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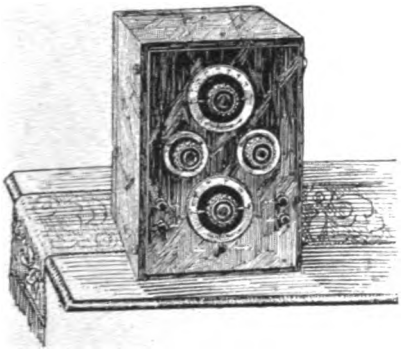
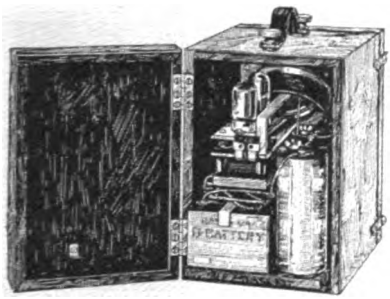
New

"Town and Country" Set

By Dr. Fulton Cutting and Mr. Bowden Washington





For more than 10 years Dr. Fulton Cutting and Mr. Bowden Washington have been designing the highest type of professional radio equipment—U. S. and Foreign Naval Apparatus, Radio for the U. S. Merchant Marine, U. S. and foreign land stations. And now, they have turned their attention to *Radio for the Home*—you can own a genuine C & W Receiver—know the simplicity, ease of operation, sharp selectivity and clear reception that characterize the best professional equipment.

At last, a successful all-purpose receiver. Out of the years of experience of Dr. Cutting and Mr. Washington has come this "Town and Country" model—a portable that you can carry with you when and where you wish—yet the perfect set for your home.

In your home, without the carrying handle, "Town and Country" is a handsome 2-tube, *double circuit* cabinet set, highly selective, range up to 1200 miles, capable of operating a loud speaker for local or near-by stations.

and then, at a turn of a switch—

it becomes a 2-tube, *single circuit* portable set—ready to operate on any sort of *temporary antenna*—a wire around the top of your car—stretched along a tent top—or across the room in the home of a friend.

It's the complete all-purpose set—no compromise. Self-contained—uses dry batteries—LARGE dry batteries that last. It's complete with Brandes Head-set—ready for antennae and ground wires when you get it—ready to give you "what's in the air." Price, $97.50. See it at a C & W Dealer's—or write for literature.

Cutting & Washington Radio Corp.

Minneapolis **Minn.**

Operating Station WLAG

Cutting and Washington

Standard of Excellence in Radio Since 1914

PRESS OF WILLIAM GREEN, NEW YORK

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The COURT JESTER of TODAY

"No wit to flatter left of all his store,
No fool to laugh at, which he valued more."
—Pope

SINCE the earliest days laughter and gaiety have been the most sought after things in life. In ancient times stately rulers unbent, courtly knights forgot seriousness; beautiful ladies became more alluring as the clever quips and merry pranks of the court jester brought a sparkle to their eyes and drove dull care away. But they were limited to the clownish antics and slap stick comedy of the jester.

Moderns have unlimited sources of amusement. Every broadcasting station has its Jester; its humorous stories; amusing songs and clever comedies. Each night the air is filled with merriment.

With a Crosley Model X-J radio receiver, amusement may be brought clearly and distinctly to your fireside. Sitting comfortably in an easy chair you forget dull care. The magic wand of the radio sends worry scurrying.

The very moderate prices of all Crosley instruments bring radio within the reach of all. No matter which Crosley Model you may select you can be assured of the maximum results at the lowest cost.

Let a Crosley Radio Receiver bring fun, laughter and good humor into your home.

CROSLEY
Better-Cost Less
Radio Products

See the Crosley Line at Good Dealers Everywhere

Write for Free Catalog. This fully describes the Crosley line of Radio receivers which range in price from the Model VI, a 2 tube set at $30, to the graceful Consolette Model X-L at $140. It also shows the complete line of Crosley parts.

Crosley Model X-J—Price $65

For tuning out local interference and bringing in distant stations this receiver is unexcelled. It is a 4 tube set combining one stage of tuned radio frequency amplification, detector and two stages of audio frequency amplification.

Nowhere can a better set be purchased at any price.

Cost of necessary accessories $40.00 and up.

CROSLEY MANUFACTURING COMPANY
Powel Crosley, Jr., President
116 Alfred Street **Cincinnati, Ohio**

CROSLEY **Model X-J** **$65**

The broadcasting station WLW is maintained by the CROSLEY MANUFACTURING COMPANY

MAIL THIS COUPON TODAY

Crosley Manufacturing Co.,
116 Alfred St., Cincinnati, O.

Gentlemen: Please mail me free of charge your complete catalog of Crosley instruments and parts together with booklet entitled "The Simplicity of Radio."

Name.....

Address.....

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Popular Radio

Edited by KENDALL BANNING

25¢

FEBRUARY
1924

In this Number—

How to Build a Three-Tube Reflex Receiver

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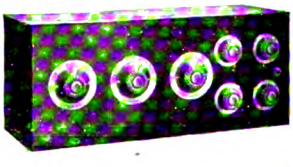
Today's Cinderella needs no fairy godmother. She calls up Prince Charming and together they waltz at her Radio Dance, while out of the air, over her C & W Receiver, comes the rhythmic swing of Schubert melodies, Strauss waltzes, fascinating modern two-steps, played by the nations best orchestras. . . . . .

Get the *Best* Program with a C & W Receiver

Tested with other broadcast receivers — on the same antenna — listening to the same stations, Model 11-B, the Cutting & Washington Receiver illustrated above, proved to give greater volume from the desired station, with less interference from all other stations.

Highly selective, a 3-tube, double-circuit regenerative receiver, with remarkably long range and clear reception. Uses dry cell A-battery; 3-UV 199 tubes; special sharp tuning C & W Circuit, shock absorbing tube mounts, automatic rheostat switches, shielded panel. Leader of the C & W Line, the set that will get your station if the station is to be had. Price complete, ready to operate, $160.

Compare — then choose. Ask for a demonstration by the nearest C & W Dealer.



Dealers—Distributors: Write at once for details of the Cutting & Washington Selling Plan — a real opportunity in Radio.

Cutting & Washington Radio Corporation
Minneapolis :: :: :: Minnesota

Cutting and Washington

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Brandes

GRANDMA'S happy now! Her busy fingers and tired eyes enjoy their well-earned rest. She's busy without working. Time doesn't drag. Long hours are lightened by the world of entertainment and fun brought to her by radio. A new interest fills her life!

C. BRANDES, Inc. NEW YORK

Matched Tone
TRADE MARK REG U.S. PAT. OFF.
Radio Headsets

© C. Brandes, Inc., 1924

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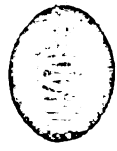
POPULAR RADIO

EDITED *by* KENDALL BANNING



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(*Cover design by Frank B. Masters*)

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

For advertising rates address E. R. CROWE & Co.
New York: 9 East 40th St. Chicago: 225 North Michigan Ave.

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"The coming of a friend from a far-off land—is this not true joy?" Confucius—

Your friends of radio come to you each night through the

GREBE

Broadcast Receiver

Doctor Mu.

THE GREBE CR-12 Broadcast Receiver is a highly efficient Radio Instrument employing both Regeneration and Tuned Radio Frequency Amplification with only two tuning adjustments.

A Dial graduated in wave-lengths enables you to locate the program you desire instantly.

Compartments are provided for all necessary batteries in the attractively finished walnut cabinet.

Requiring no cumbersome storage battery nor unsightly wires, this Instrument will grace your library or living room.

Write for "GREBE Radio in the Well-appointed Home"

GREBE RADIO

A. H. GREBE & COMPANY, Inc.
Richmond Hill, N.Y.
Western Branch, 451 East 3rd St., Los Angeles, Cal.

Licensed under Armstrong U. S. Pat. No. 1,113,149 Type CR-12

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PAGES WITH THE EDITOR

ON the bulletin board of the advertising department the Editor has just read a notice that is so completely in accord with his own policy of guarding the interests of our readers that he is printing it in full below. It not only furnishes impressive evidence of the truth of this magazine's oft-repeated assertion that *"the editorial pages of* POPULAR RADIO *are not for sale,"* but goes even a step further; it proclaims that even the *advertising* pages of POPULAR RADIO are not for sale—unless the buyer meets the prescribed standards!

* * *

Here is the notice in full:

"LAST week alone we refused orders for 16 pages of non-radio advertising. Our advertising pages must remain as all-radio as the editorial pages.

"We refuse, monthly, from 5 to 10 pages of cut-rate-house advertising—and advertising from houses that tend to sell imperfect goods or that substitute inferior brands.

"We extend no credit to the slow-pay advertiser. This costs us, monthly, at least 5 pages of advertising from fly-by-night concerns.

* * *

"I EXPECT to secure for POPULAR RADIO within another year, an average of at least 150 pages of advertising a month and I expect to secure this volume by virtue of a courageous enforcement of three major policies;

"1st—*Unquestioned editorial integrity.* No advertiser can buy any mention of his goods in our editorial columns.

"2nd—*A reasonable advertising rate,* based on a circulation guarantee.

"3rd—*The protection of our advertisers as well as our readers* against the unfair competition of

(a) Non-radio advertisers
(b) Cut-rate houses
(c) Fly-by-nights."

* * *

FROM Boston, the traditional if disputed center of culture in the United States, comes an official order from the director of the Department of Education for the renewal of the Department's subscription to POPULAR RADIO. The growing use of POPULAR RADIO in our schools and colleges furnishes gratifying evidence of the high standing that this magazine enjoys in scientific circles.

* * *

HERE is a rare chance for an experienced radio amateur with a soul for adventure—a chance that comes from a thoroughly responsible source, too, that is personally known to the Editor:

Sometime in September, 1924, a small group of scientists, photographers and adventurers (including one radio operator who is yet to be selected) will set sail from New York in a 150-foot, two-masted schooner with auxiliary engines, for a four years' cruise to the West Indies, South America, Africa, the Mediterranean, India, China, Japan and other points, east, west, north and south.

* * *

"DON'T you know of some good young radio amateur who would like to join us and operate our radio apparatus for us? Someone who would take the trip for just pocket-money of about $10 a week?" the leader of the expedition asked the Editor.

* * *

THE Editor cannot undertake to answer the flood of inquiries that this call for volunteers will bring in. But he *will* see that all letters addressed "The Leader of the Expedition," care of POPULAR RADIO, will be delivered to the right person.

* * *

THE demand for some of the back numbers of POPULAR RADIO, particularly for the January, 1923, number that contains Mr. Cockaday's now famous article, "How to Build a Real DX Regenerative Receiver," and for the May, 1923, number that contains his even more popular article, "How to Build the New Four-circuit Tuner," has been so widespread that these two issues went out of print within a few days. In order to accommodate our readers, however, we have had special re-prints made of these two articles; copies may be obtained for 22 cents each upon application to our Subscription Manager.

* * *

"I HAVE been a reader of your wonderful magazine beginning with your first issue and I have followed its marvelous advance. I sincerely think that POPULAR RADIO is the best magazine for the radio fan."

—A. C. CORNWALL

* * *

"CONGRATULATIONS on the chaste simplicity of your recent covers," writes Charles W. Goddard, the well-known dramatist—and perhaps the first dramatist to use radio in a play, as far back as 1906. "Whoever thought of such daring subjects—life-size productions of a piece of wire with a knot in it? Here are some suggestions for more covers equally simple:

"1. A small rubber band
"2. A toothpick
"3. A baked bean
"4. A match
"5. A pin"

Well, at least our covers offer more variety than—constitute a departure from—the conventional pretty-girl covers!

* * *

THE silver covers that make POPULAR RADIO so distinctive in appearance (so far as the Editor knows, this magazine was the first to adopt a metal-tone cover as a standard) have proven so unusually successful that other peri-

(Continued on page 6)

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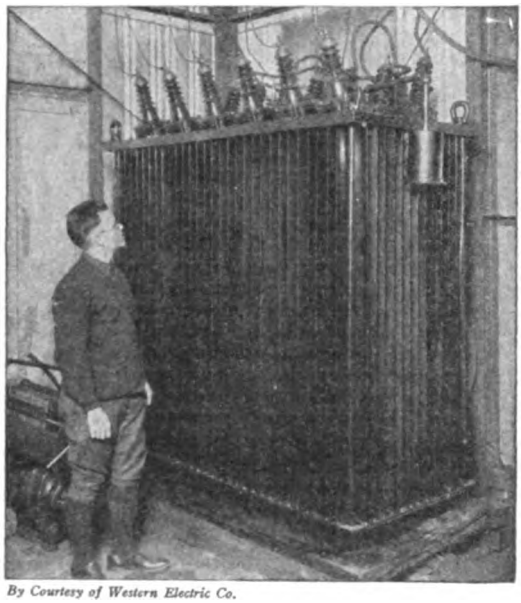
They differ in size but not in efficiency

The photograph at the right illustrates the special service transformer installed at the Radio Central, Rocky Point, L. I., for talking across the ocean.

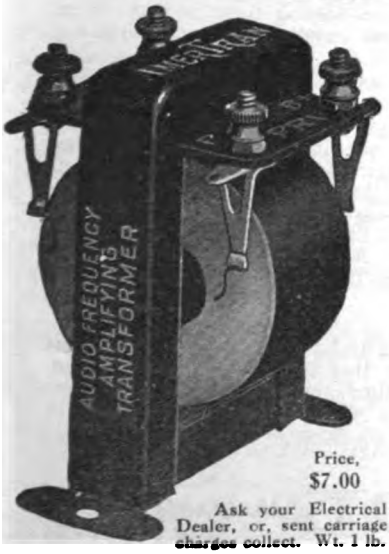
The photograph in the lower left-hand corner illustrates The AmerTran, an audio frequency transformer designed for the receiving sets of amateur and professional alike.



By Courtesy of Western Electric Co.

300 k.v.a., 60 cycle, 3-phase, 22,000 volt, oil-cooled special service transformer, Radio Central, Rocky Point, L. I.

—With all tubes— **AMERTRAN** TRADE MARK REG. U.S. PAT. OFF. *—In all stages—*



Price, $7.00

Ask your Electrical Dealer, or, sent carriage charges collect. Wt. 1 lb.

Each is the result of a long and varied experience in transformer design. Each represents the highest degree of radio engineering knowledge and craftmanship.

In designing The AmerTran, the **first consideration was** tone quality; the second consi**deration, amplification.** Its flat-top distortionless ampli**fication curve assures** faithful reproduction of speech **and of music over the** full musical scale. In one stage **audibility is increased** 30 to 40 times in the flat part of **the curve, depending** on the tube constant—the amplification **is approximately** 5 times the tube constant.

Type AF-6: turn ratio, 5:1

Send for Circular No. 1005

American Transformer Company

Designers and builders of radio transformers for over 22 years

175 Emmet Street :: Newark, N. J.

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(Continued from page 4)

odicals are following in the trail. Gold, copper and bronze covers are now beginning to peek out on the newsstands—but POPULAR RADIO still stands alone with its "sterling" standard.

* * *

FROM Earl K. Nixon of Ironwood, Michigan, comes this commentary that pigeonholes POPULAR RADIO in a niche all of its very own, and which at the same time classifies it with the world's best:

"As a subscriber and booster for POPULAR RADIO I wish to congratulate you and your management on the splendid development of your magazine as a disseminator of 'what a radio enthusiast wants to know! I consider your publication as occupying the same position in its particular province as do the New York *Times*, the *Review of Reviews*, the *National Geographic* and others of that caliber in theirs."

* * *

WHAT poet was it who sang of the "dreamy, heavy-lidded Southland"? Twice within the past week our Technical Editor has received long-distance telephone calls from eager and impatient radio fans down in Dixie who could not wait for letters to reach us; the latest call comes from B. F. Wilson of Thoebus, Virginia.

* * *

IF this practice spreads the Technical Editor will plumb have to do his work in seclusion!

* * *

No letters that come to the Editor from our readers give greater power to the editorial arm than those that endorse this magazine's policy of maintaining an absolute divorce between the advertising pages and the editorial pages—a policy that has been insistently maintained from the very beginning, and which will be maintained without fear or favor. The Editor believes that to guard the integrity of the editorial pages is a matter of fundamental importance. He believes such a policy is necessary if the readers are to be protected from endorsements and opinions that are paid for by commercial interests. More, he believes that such a policy is the only honest policy.

* * *

No advertiser or prospective advertiser has ever caused the Editor to either insert or omit from the reading pages of this magazine a single word of text or a single picture. Our principles and our opinions cannot be bought or sold.

* * *

"THE *editorial pages of* POPULAR RADIO *are not for sale.*"

* * *

AND out of the mail bag the Editor again picks at random one of the scores of letters that reflects the effect of this policy upon our readers; it comes from Jack Gaerity of North Branch, Minnesota:

"The reading of your personal remarks in your most excellent magazine makes me feel as though I knew you personally, as though you were an old friend. I want to compliment you on the high standard of your editorial policy, and to say that I think your magazine the best radio publication in America."

* * *

TWENTY months ago POPULAR RADIO was a little pamphlet of 72 pages. The issue that you hold in your hand contains 228 pages—a growth of 315 percent! One of our subscribers, Harry E. Pratt, principal of the Albany (N. Y.) High School, who has been watching this unusual growth, something more than hints at the reason for it when he writes:

"I have just been comparing your first issue with the November number. Some progress! The reason is obvious. POPULAR RADIO is justifying its name. Congratulations and good wishes!"

* * *

"YOUR magazine makes amateurs like myself feel that we are listening in on real stuff." writes R. L. Hilton of Waterville, Maine. And to prove that he is willing to back his convictions, he encloses a year's subscription.

* * *

So many readers of POPULAR RADIO have written in for extra copies of back issues that contain the famous "How to Build" articles that three issues of the magazine are now entirely out of print. In order to accommodate our friends, however, two of the much-demanded articles have been reprinted in pamphlet form. And now these reprints are going out of print!

* * *

THERE seemed to be only one logical solution to this problem of supplying reprints of these articles—to publish them in book form. And that is what POPULAR RADIO is doing.

* * *

THE seven most remarkable and most efficient sets of their kind that have been described in the pages of this magazine—ranging from the improved crystal receiver up to the new and improved four-circuit tuner and the new regenerative super-heterodyne receiver—are being published in a book that is now in the hands of the printer, *How to Build Your Radio Receiver*, edited by the Editor and by the Technical Editor of this magazine.

* * *

THE book will be ready shortly after the publication of this issue of POPULAR RADIO, and for a limited period only a copy will be presented free with a year's subscription to this magazine at the $3.00 rate.

Kendall Banning

Editor, POPULAR RADIO

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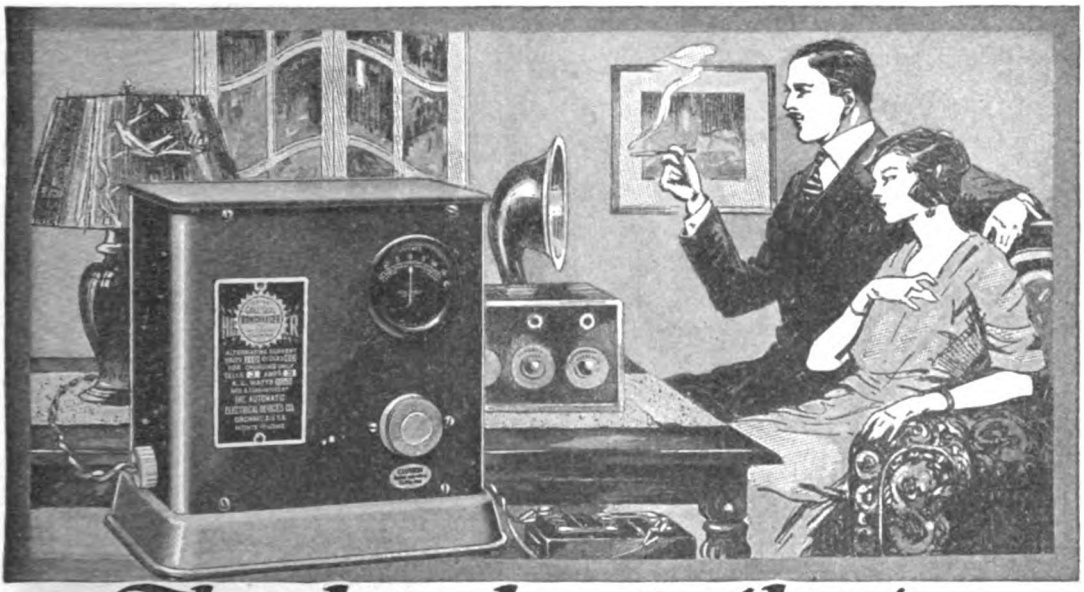

The hook-up that eliminates battery trouble

Some radio fans are still slaves to their batteries—lug them to service stations every time they need recharging—allow them to spoil many evenings' entertainment by running low.

Other fans—and they're quickly coming to be the vast majority—have found new economy and convenience in the GOLD SEAL HOMCHARGER, the world's best as well as its most popular rectifier. With it any radio or auto battery can be charged at home *overnight*—for a nickel. Simple, dependable, practically silent and absolutely safe. Beautifully finished in mahogany and gold. Approved by Underwriters. UNQUALIFIEDLY GUARANTEED. Over 150,000 now in use.

WHY PAY MORE—OR GET LESS?

Why buy a 2 or 3 ampere rectifier *without ammeter* requiring from 40 to 50 hours to charge your battery and costing twice as much to operate when, for the same price, you can secure the genuine 5-ampere GOLD SEAL HOMCHARGER which does a better job in one third the time and at half the cost. Fitted with high grade ammeter (eliminating guesswork) charging cable and battery clips—no extras to buy. For sale by all good dealers—$18.50.

Insist on the GOLD SEAL

ACCEPT NO SUBSTITUTE. No other CHARGER is just as good. Insist on seeing our registered trade mark, the GOLD SEAL, on name plate and carton before purchasing.

RADIO FANS—ATTENTION!

FREE **Ask your dealer for a free copy of the HOMCHARGER international list of broadcasting stations. Contains call letters, location, name and wave length of nearly every broadcasting station in the world.**

DEALERS—JOBBERS!

Prepare for the big HOMCHARGER year ahead by writing today for a copy of our elaborate merchandising plans. In it is illustrated many attractive sales helps that will enable you to get your share of this business.

The Automatic Electrical Devices Co., 132 West Third St., Cincinnati, O.

Largest Manufacturers of Vibrating Rectifiers in the World

GOLD SEAL HOMCHARGER

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Model X

$285 Fully Equipped With Built-in Loud Speaker

This radio receiving unit is a newly perfected development of the Kennedy Engineering Staff. It is unusual in that it combines extreme simplicity of operation with the same scientific accuracy and selectivity that characterized the earlier Kennedy models. After an initial setting is made only one dial is required for all tuning. And, when a dial setting of a station is once determined, that station will always "come in" at its own setting regardless of where the receiver is used.

It is stable in operation, reproduces music and voice with remarkable faithfulness and has established some unusual distance records. Responds to all broadcast wave-lengths—operates on any antennae, outside type preferred. "Re-radiation" has been practically eliminated.

Beautiful Radio Furniture = *the* New Kennedy Receiver, Model X

As a graceful piece of furniture, the Kennedy Radio Receiver, Model X, makes a charming addition to any home. The cabinet is of mahogany, hand rubbed to a beautiful finish—with its delicate inlay of satinwood and ebony and the grill at the front, it is truly typical of the Sheraton design. A loud speaker of superior quality is built into the cabinet—by this means faithful reproduction of music and voice is available to an entire family or assembly of guests.

The control panel is symmetrically balanced and immediately indicates the remarkable ease with which the receiver may be operated—the angle at which it is set is the result of much study to provide greater comfort while tuning.

The receiving unit in Model X is everywhere recognized as one of the most noteworthy achievements in radio development—particularly since it sets a new standard of operating simplicity in combination with the precision and selectivity that have always been a feature of Kennedy radio receivers.

The price of Model X, completely equipped with all tubes, dry batteries, built-in loud speaker and individual Kennedy 3,000-ohm phones, with plug, is $285.00. Other models range from $125.00 to $825.00, completely equipped.

Ask your dealer to show you the new Kennedy Radio, Model X, or write us direct for fully illustrated literature.

THE COLIN B. KENNEDY COMPANY
St. Louis San Francisco

All Kennedy receiving sets are regenerative.
Licensed under Armstrong U. S. Patent No. 1,113,149.

KENNEDY

The Royalty K *of Radio*

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He Interprets Radio Messages from Atoms

By studying the electromagnetic waves sent out from hot atoms in the form of rays of light, Professor Niels Bohr of the University of Copenhagen, has discovered that the atoms of matter are really tiny solar systems each with suns and planets of its own. These marvelous new theories will be described in an early number of POPULAR RADIO.

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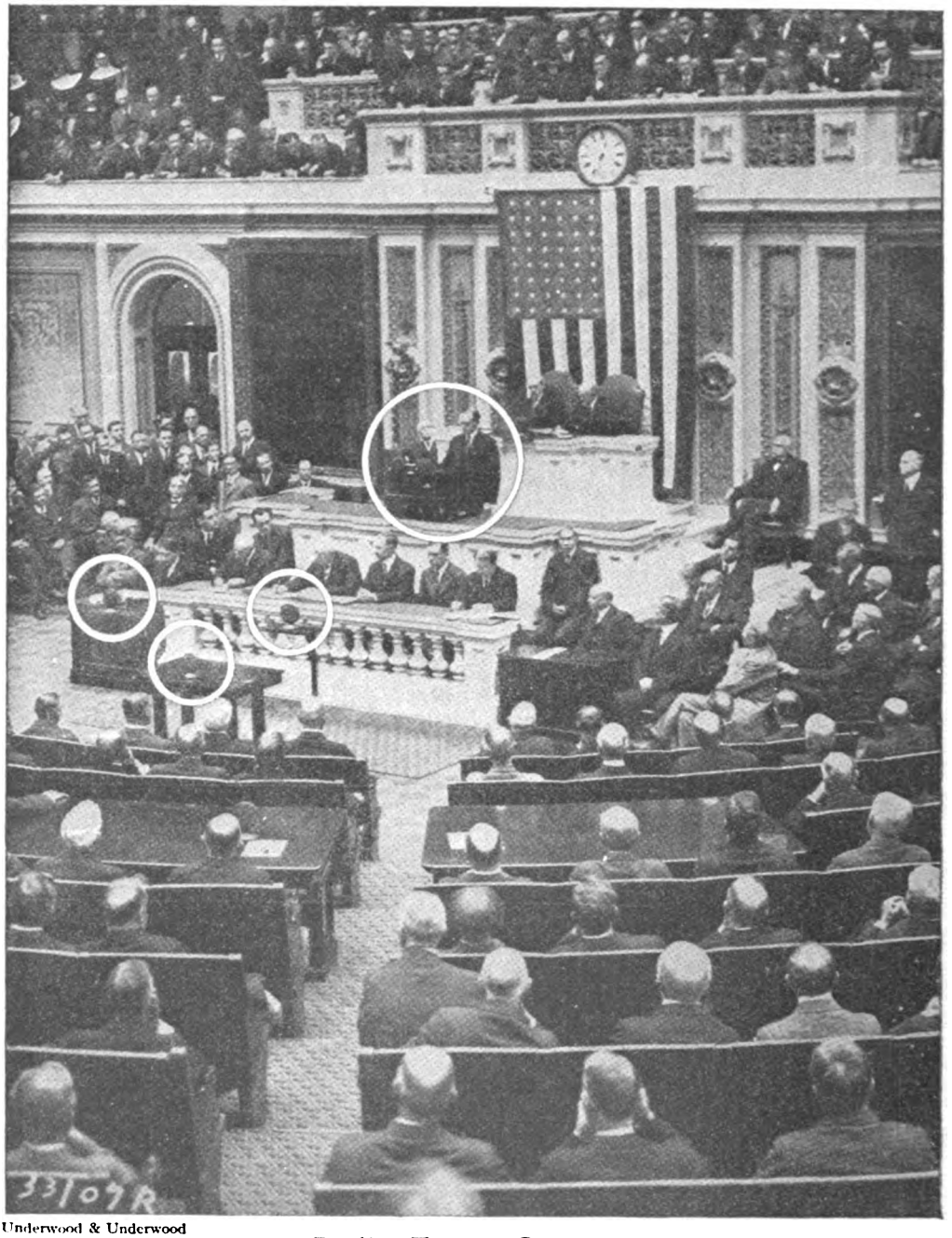

Underwood & Underwood

Radio Enters Congress

So complete were the arrangements for broadcasting President Coolidge's first message to the 68th Congress on December 10, 1923, that practically the entire United States could have listened in and heard his voice. Notice the two microphones on the Speaker's desk and the three immediately in front of it.

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Popular Radio

VOLUME V FEBRUARY, 1924 NUMBER 2

The Coming Kingdom of the Ether

Some day we will watch events that transpire at a distance as easily as we watch motion pictures now. Some day we will use radio for reading thoughts, for heating and lighting our homes, for curing our diseases, for furnishing motive power to our railroads and factories. Some of the wonders that are in store for us are told in this prophetic article by "the Edison of England"—

PROF. A. M. LOW, A.C.G.I., D.Sc., M.I.A.E., F.R.G.S., F.C.S.

THERE is not the slightest doubt that no invention since the Stone Age has developed with such amazing rapidity as radio. Already it has proved itself to be one of the most powerful forces controlled by man, and it has vast possibilities—so vast that the scientists of the world cannot predict its ultimate evolution. The fact that at present radio is without any reasonable degree of secrecy, is one illustration of the immature nature of the science.

The world's knowledge of radio science is literally in its infancy.

It is obvious, therefore, to all thinking people, that as each hundred years of the world's history has seen a greater advancement of civilization this progress cannot be expected to stop today, and in the near future we may expect rapid developments of radio and other inventions for the benefit of mankind. Already the ordinary person enjoys far greater comforts than the royalty of olden days, and it is interesting to take a peep into the future and try to gather some idea of what life holds in store for us.

For the benefit of those people who are inclined to scoff at logical scientific probabilities I would remind them they owe the clothes they wear, the food they eat, and the very bed they lie on, to the much abused scientist.

We have speeded up radio communication to the extent of sending a message round the world in one-seventh of a second. Having solved the problem of sending a message we now want to *see* the person with whom we are in communication, therefore "television"—or radio sight—may be expected to develop quicker than many other branches of radio science.* It should not be far in the future when we shall take radio sight

*See "The New Radio Movies" in POPULAR RADIO for December, 1923.

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for granted in the same way as broadcasting is taken for granted at present.

More than seven years ago I obtained successful vision over half a dozen miles of ordinary telephone wire, and there is no reason why equal, or better, results should not be obtained by radio.

The possibilities of radio sight are unlimited and many events in our everyday life will no longer be barred to us owing to the expense and difficulty of transporting ourselves from place to place. Half the necessity of travel will be gone and by this means all business will be speeded up, heads of commercial firms will see and speak to each other from their office desks and the busy man who breaks a limb, instead of neglecting his work while in bed will keep in touch with things with the aid of radio. Facility of communication is the backbone of civilization and often a preventive of war.

All this will be a valuable educational asset, for when a lecture is held by a specialist at any college it will be possible to "connect" a dozen other schools by radio, the pupils seeing and hearing by that means. This will bring the most expensive education within the reach of all.

In wartime, television will have many uses, radio-controlled airplanes and torpedoes will be watched by this means and bombs will be released from the airplane at will. Laid mines will be watched and exploded by radio at any given moment. Army commanders will see their directions being carried out. It will be difficult to move troops and guns as every bush may conceal these radio "eyes."

Another important use to which television will be put will be the detection of crime, for naturally all radio developments will speed up police methods and the life of the criminal of the future will be precarious indeed.* By attaching radio microphones and television machines in the known resorts of criminals the police could literally keep their eyes on suspected characters. This would be particularly useful in cases of blackmail, for the very walls would have "ears" and "eyes." The apparatus would be inconspicuously placed as it would require no connection, by wire or otherwise, with the watching detectives!

Another exceptionally useful branch of radio science that will help us in many ways in the future is radio control.* It will no doubt play a big part in our lives. At the present time it is in an elementary stage, but experiments are being constantly conducted in many countries with good results and it is mainly a question of time before it is brought to a sufficiently advanced stage to make many of our dreams of today the exceedingly useful realities of tomorrow.

Radio control will be used to control airplanes, torpedoes, submarines and tanks both in peace and wartime. And one valuable asset will be the fact that pilotless airplanes with smaller and lighter engines could rise to the upper air and attain terrific speeds where the wind resistance is less, although lack of air prevents a pilot flying at that height today without special precautions.

Mails could be sent by these small radio-controlled airplanes at a great speed to all parts of the world. This would be particularly useful over jungle and desert places where the present transport is difficult and slow. Fire alarms, public clocks and ticker machines will be controlled. Compass control will be given to ships from underwater cables. Pilots flying at night and in fogs will be assisted by radio control. Eventually I believe that trains, street-cars, and many motor vehicles will be controlled. It is possible that underground wires may give both direction and power to all kinds of travel in the far future.

One of the main points of radio control is that all signals are sent by a secret combination of different wavelengths, on

*See "Running Down Lawbreakers by Radio," in POPULAR RADIO for June, 1922, and "Radio Puts On Gum Shoes" in November, 1923.

*See "How Machines Are Controlled by Radio," in POPULAR RADIO for August, 1922

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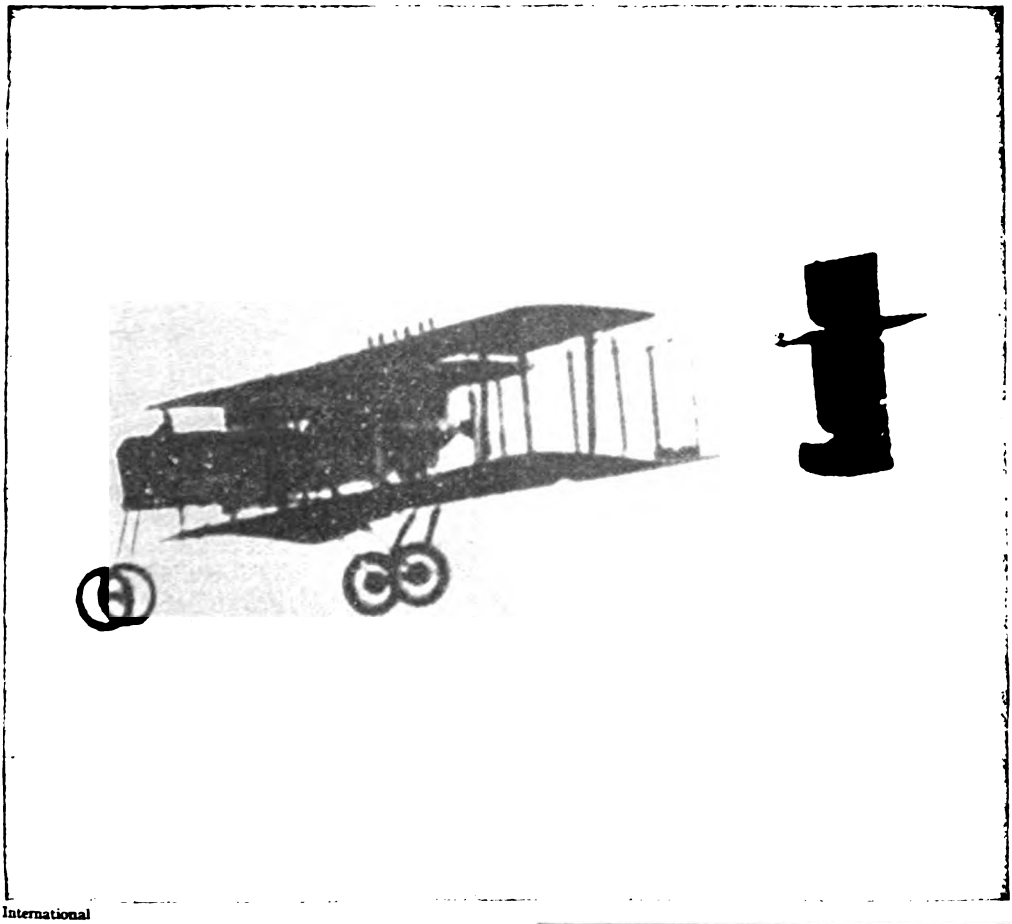


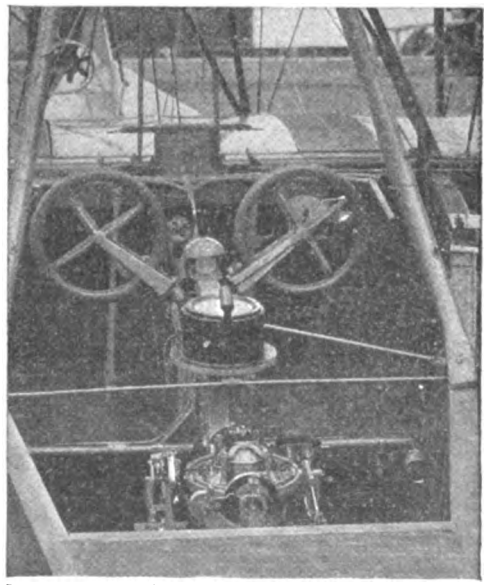
International

A RADIO-CONTROLLED AIRPLANE IN FLIGHT

In recent experiments at Villesauvage, near Paris, an airplane that was unprovided with either pilot or passenger was made to take off from the ground, fly and land safely—all by radio signals transmitted from a ground station. Its stability (which is automatic) was controlled by gyroscopes connected to auxiliary motors; when landing, the machine when about ten feet from the ground, righted itself and automatically shut off the motor. After touching the ground the motor was again automatically started and the plane rode along the earth until the stop was made.

THE AUTOMATIC PILOT

The apparatus shown in the picture at the right is the Sperry "gyroscope pilot." Once set for a given course this pilot will keep the airplane balanced and on that course without further attention.



Sperry Gyroscope Co.

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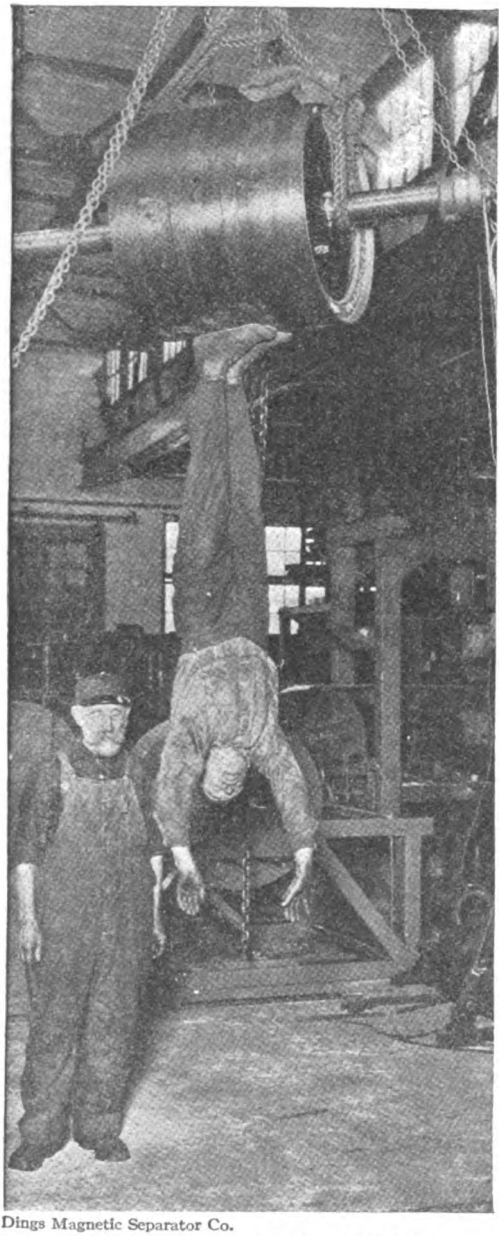

Dings Magnetic Separator Co.

HELD UP BY RADIO WAVES

This man is suspended by the attraction of this magnetic pulley for the nails in his shoes, an attraction which is transmitted, scientists believe, by a variety of electromagnetic waves originating in magnetized atoms. When we understand these magnetic waves more fully there will be, the scientists predict, not only a new knowledge of the inmost secrets of matter but many new uses for magnetism, which means, really, a new importance for all kinds of ether waves and probably for radio as well.

the principle of the ordinary letter-lock. Unless this exact combination of wave-lengths or sending speed in known and used there is little possibility of any other station gaining control of the subject.

Another interesting radio development is the transmission of photographs by that means. This is not really a difficult matter at the present for photographs could be sent by wireless and reproduced equally well—or better—than the cabled pictures published by newspapers in recent years.

While experimenting as far back as 1911, I was successful in transmitting a partial photograph over a distance of four miles—and methods have much improved since then. I believe that photographs of current events from all parts of the world will be included in the radio-broadcast programs of the future, the news bulletin being supplemented by views of the events mentioned.*

Radio photographs will be sent to the newspapers from every corner of the globe and reproduced as quickly as messages are received now. This will be particularly unpleasant for criminals who will find their description and photographs circulated with lightning speed.

Little is heard of transmission of light by radio at present, but although it is in an elementary stage it will be of value to us in the future. We are so sufficiently advanced in experiments with this branch of science that I can place six bulbs on a table, without any connection whatever, and light them with an expenditure of about two horse-power, keeping them brightly burning for any length of time. The radio-control delay in lighting or extinguishing the lamps is only three-fifths of a second.

In the far future I think radio light will be broadcast generally. All shops, houses and factories will be lighted from this source, the light being tapped through a meter as required. It is a curious fact that if we could only slow

*See "Seeing by Radio," in POPULAR RADIO for April, 1923.

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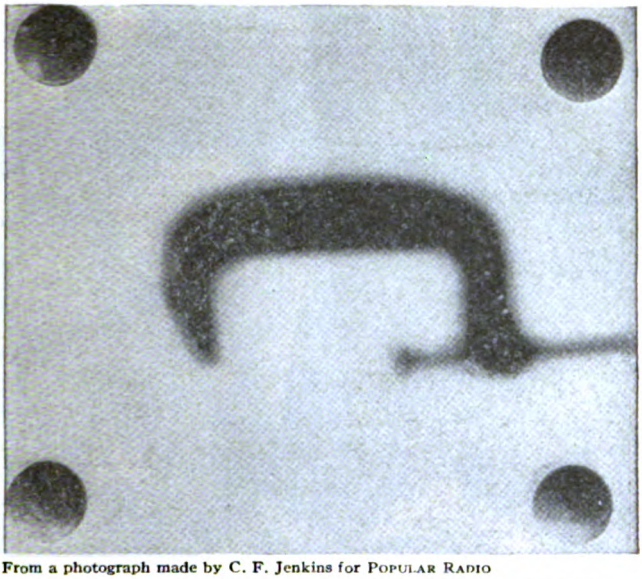

From a photograph made by C. F. Jenkins for POPULAR RADIO

THE RADIO-PROJECTED IMAGE OF A MOVING OBJECT—AS SEEN BY THE OBSERVER MILES AWAY

The inventor, Mr. C. Francis Jenkins, held up this clamp before his radio transmitter; its image was sent and received through the ether as you see it here. This is a striking example of the use of television which Professor Low foresees will soon be as common as the telephone is now.

down the speed of the radio waves sufficiently they would become visible and the whole atmosphere round a broadcasting station would be lit up!

Radio writing, on which many experimenters are now working, will assist further in the general speeding up of our lives and business by rendering travel almost unnecessary. The business man of the future will be enabled not only to see and speak to other firms, but to write to them from his chair. Documents can be signed at a distance. Checks can be signed by radio, the cashier watching by television.

Drawings and plans of every sort can be sent by radio. Survey airplanes can instantly transmit their work to the earth. Radio writing will be put to many other uses. A final invention that we still lack is a machine that will type to radio dictation!

I believe that in the far future growing children will be given by radio a continual mild curative treatment to build them into first-class citizens. Radio heat will be sent out to districts where the weather conditions are destroying crops. The world will benefit in many strange ways by that wonderful force—radio!

Much interest has been aroused recently by reports in the European newspapers that the repeated failure of French airplanes while flying over German territory may be due to the action of secret rays discovered by the Germans, who are known to have been experimenting for some time with directional radio.

Several theories have been advanced to account for the forced landings of the French airplanes. One is that by the concentration of a secret wireless ray, or combination of rays, the magnetos of the airplane may be affected. This theory is, in my opinion, negatived by the fact that magnetos in airplanes are protected by metal cowls. It would be almost impossible for a ray to reach the magnets without damaging the metal covering also. In no case has this been reported.

Another theory is that a new ray has

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Crouch, London

HE PHOTOGRAPHED THE NOISE IN THE LONDON SUBWAYS

Professor A. M. Low is said to have produced more useful inventions than any other man in England. He is an expert designer of automobile and airplane engines, has invented a system of radio control for battleships and has made photographs by using the invisible infra-red rays. Recently he invented an apparatus for photographing the noise in the London subway as a part of a successful effort to make the trains less noisy.

been discovered which will melt certain metals, it being pointed out that most of the forced landings of airplanes flying between Strasburg and Prague have occurred in the vicinity of the German airdrome at Furth. I am confident that at the present time it is impossible to transmit sufficient power through the air to bring down an airplane in flight at, say, two thousand feet. The claims advanced certainly seem far-fetched and are out of all proportion to the state of experiments at present.

For some time now many scientists have been working along the lines of discovering a force which can be projected through air at airplanes; the problem is to discover the best means of sending in the form of oscillations a force which, on coming into contact with metal will generate heat. If this force could be concentrated and made sufficiently powerful the rigging of the airplane could be melted and the machine would be brought down.

In order to dispel any doubt as to the possibility of the transmission of induced radio power at the present time I might mention that by an expenditure of about three horse-power we can totally destroy a thin iron wire at a distance of about three feet without any connection between them.

I am quite confident that in about fifty years time, with five thousand horse-power at our disposal, we should

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WANTED—Five Inventions

IN the Institute of Patentees in London is kept a book in which members of the Institute and visitors are asked to set down notes of inventions that are believed to be needed by the world. It is called the "What's Wanted" book. In this book Prof. Low, the author of this article, has set down a list of what he believes to be needed inventions. Here are five of them that relate to radio:

1. *A method of utilizing atomic energy.*
2. *A selective method of radio communication with really sharp tuning.*
3. *An efficient method of varying radio-oscillation frequencies over an almost unlimited range.*
4. *A loudspeaker that is controllable without distortion.*
5. *Improved methods of electrical storage and power transmission.*

be able to send a sufficient force to bring down an airplane in flight if it is not protected in some manner.

Even at an earlier date it should be possible to momentarily divert the several thousand horse-power of a giant airplane's engine in order to destroy the vital parts of another airplane circling within fifty yards of the first one. As practically all air fighting takes place within that fifty yard radius this should be a powerful weapon. Elementary experiments have been successful and we may expect this branch of radio science to be of real use later.

The difficulty at the present time is that we can only receive a minute fraction of the power sent out, even a short distance away, for the reason that this power is broadcast in every direction. This will be overcome in the future when radio is directional and it will become so, perhaps, by using induced currents of high frequency to break down the resistance of the air-gap or by the use of light or some other wave as a carrier.

The mistaken impression exists that the use of radio heat as a destructive agent entails sending waves of heat through the air. This, of course, is absurd for it is impossible to generate enough heat to travel any distance. It would exhaust itself on the journey. The problem is to transfer the energy as electric oscillations and make these generate heat when they actually strike the metal. It is with a view to solving this problem that experiments are now being conducted.

I have frequently been asked if I thought there would be future wars. Certainly I do think so. War is *natural,* for all nature fights. Although world war may become less frequent, I hope it will, for mankind to cease to fight would be as strange as if they lived for ever. I am in complete sympathy with the objects of the League of Nations, but it will not be successful in preventing further warfare.

The science of warfare will naturally advance considerably in the future and

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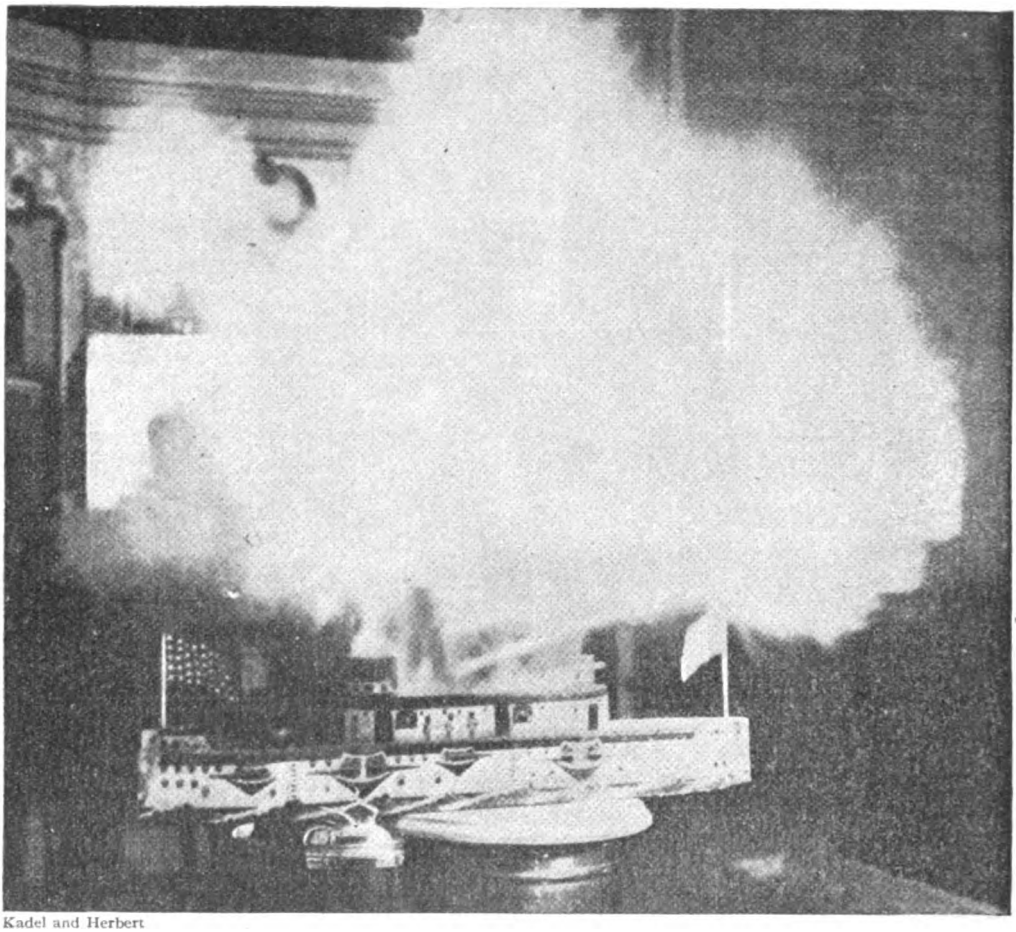

Kadel and Herbert

HOW A MODEL BATTLESHIP MAY BE BLOWN UP BY RADIO

Infernal machines secreted in the magazine of a battleship can be blown up by radio waves from outside. When the directed beams of radio energy which Professor Low foresees have been perfected it may be possible to blow up any battleship magazine in this way. Will this mean the end of war—or radio-protected battleships?

radio and other developments will make it infinitely more terrible.

A new weapon which I feel sure will be used in future warfare will be the projection of liquids heavily charged with electricity. A man standing in the path of the stream receives a shock that disables or kills. Another new weapon against airplanes may be a type of electrically-controlled rocket operated on a wire.

Deadly germs and many forms of poison gas will play a big part. Vortex-clouds of hydrocyanic-acid vapor will probably be released in the path of an invading air squadron at a sufficient height to render them innocuous to those below but deadly to any one who crosses their path.

The machine gun of the present will develop into an electric-impulse gun firing enough bullets a second to render a miss unlikely.

There will be armored boats capable of diving under water and flying in the air. Airplanes flying with silent engines will need colored searchlights to pick them out, for aerial camouflage will be a fine art.

Machinery for rapid tunnelling will be

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necessary—because with the introduction of radio-sight night will afford no cover and there will be great activity underground. Future warfare will be so terrible that no country would be able to stand the strain for long.

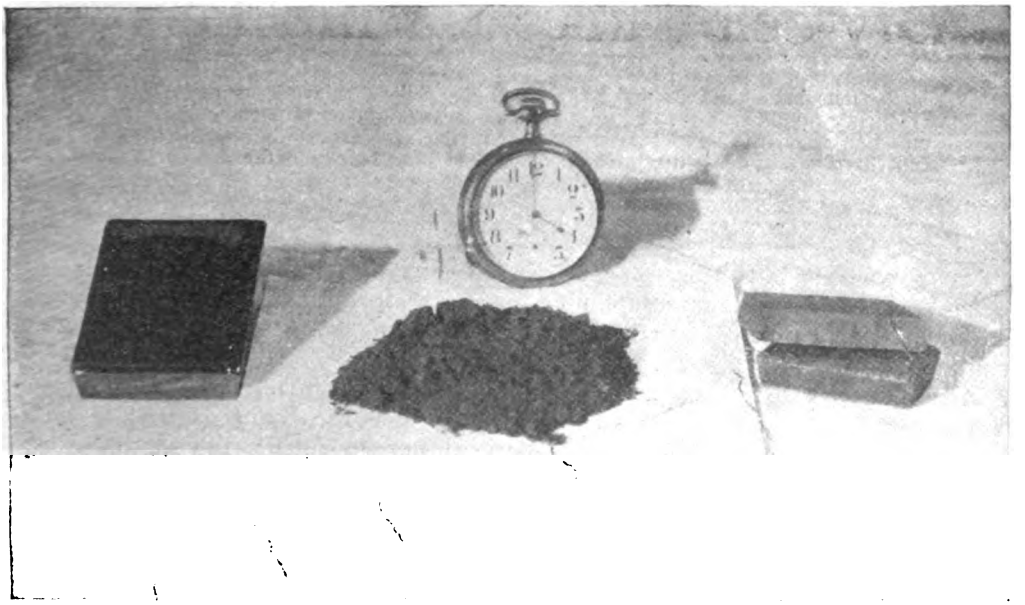
Many absurd claims have been advanced by tricksters who profess to practise mental telepathy. At the present time this is not a scientific possibility. However, there is a real need for this development of communication and necessities have a habit of becoming realities.

Most sciences are begun by tricksters. Just as the alchemist has developed into the chemist; so mental telepathy, commencing as trickery, may develop into a scientific fact. We know that thought is an electrical process. The energy expended in thought must go somewhere, therefore, it might be utilized eventually to transmit the thought to another mind.

One might argue logically that speech of all kinds is a rough-and-ready physical method of communication and that in the future we shall be able to converse with each other by some form of suggestion. This would enable us to do without the actual physical meeting of two people who wish to discuss an idea. After all, if I wish to convey a thought to anyone it seems very crude that before I can convey the idea that is in my mind I have to wiggle my mouth and puff irregular gusts of wind through my lips in order to produce sound!

I think that, in all probability, the future will find mental telepathy existing in some form or other.

After reviewing the amazing progress made by our civilization in recent years it is obvious that the future holds many strange and wonderful things in store for us—and who would now dare to say that such a thing as an "impossibility" exists! The study of oscillation may be the key to discoveries far more wonderful than radio. The unexplored spectrum has yet to hint to us the meaning of life itself.



Raritan Copper Works, photographed especially for POPULAR RADIO

THIS IS WHAT IS USED IN "RADIO EYES"

Most of the devices for "seeing by radio" depend on this chemical element called selenium, which changes its electrical conductivity whenever light falls on it. The three known varieties of selenium are here shown: the glassy variety is at the left, the powder variety in the center, and the metallic variety at the right.

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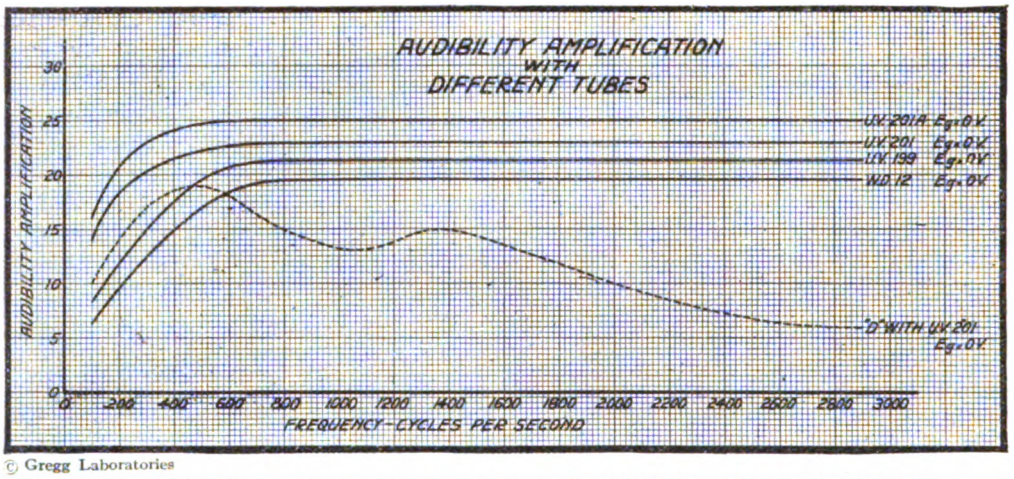
AUDIBILITY AMPLIFICATION WITH DIFFERENT TUBES
AUDIBILITY AMPLIFICATION
FREQUENCY-CYCLES PER SECOND
UV 201A Eg 8 V.
UV 201 Eg 8 V.
UV 199 Eg 8 V.
WD 12 Eg 8 V.
"D" WITH UV 201 Eg 8 V.

© Gregg Laboratories

A GROUP OF FREQUENCY-AUDIBILITY CURVES FOR AMPLIFYING TRANSFORMERS

FIGURE 1: *The four top curves in heavy black lines show the audibility record of one transformer used in connection with four different types of vacuum tubes. Notice that the amplification is constant over a wide range of audio frequencies. This is a good transformer; it does not distort but it amplifies with equality all the frequencies within the range shown. The lower dotted curve shows the audibility of a poor transformer. Notice how the amplification falls off at the higher frequencies. This transformer would produce distortion.*

HOW TO USE THE

Dry-cell Tubes as Amplifiers

Many fans have tried to make the small dry-cell tubes work as audio-frequency amplifiers; usually they get poor results. This problem comes up often when the builder of a radio receiving set has not the facilities for charging storage batteries and must, therefore, resort to the smaller tubes. This article tells specifically how to do it.

By FRANK A. HINNERS, I.R.E.

MANY laymen who are thinking about joining the ranks of broadcast listeners, and even large numbers of broadcast listeners of experience, find it difficult to decide when to use, and when not to use the dry-cell tubes.

When portability is required above all else, the dry-cell tubes obviously recommend themselves. Even when portability is not a factor but the consideration of small first cost and low upkeep is important, the dry-cell tubes have much to recommend them. The cost of a storage battery and the charging appliance represents a considerable sum, which is, of course, unnecessary with dry-cell tubes.

The dry-cell tube used for some purposes performs quite as well as the larger storage-battery tubes, yet for other purposes it cannot equal the large tube.

To mention some examples, the dry-cell tube fitted with the proper grid leak when used as the detector in regenerative receivers, produces results closely approaching the larger tube, if not in signal volume, certainly from the

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DX standpoint. Used with the proper grid leak in non-regenerative receivers in which radio-frequency amplification is *not* incorporated, results equalling but not excelling the crystal detector are the rule. I refer to the WD-12 tube operated from a single dry cell. Operated in this type of receiver, *without* proper grid leak, results are inferior to a crystal detector. As we are considering the amplifying properties of the dry-cell tube here, its detector action cannot be described at length; sufficient to say that the dry-cell tubes, which are of the hard, highly exhausted type, are not especially sensitive detectors.

In choosing between the two general types of tubes now in use, storage and dry-cell operated, the public finds itself confused by much conflicting information. Many, attracted by the lower first cost of the dry-cell tubes, buy them with expectations of a performance equal to the larger tubes. Frequently, disappointment is a result, because the listener expects too much from this type of tube—due to no fault of the tube. Were the information regarding the dry-cell tube available in quantitative form, instead of the prevalent terms such as "good," "fair" and "poor," the truly remarkable merit of this form of tube would become known and needless disappointments, therefore, avoided.

In order to supply this quantitative information, a series of observations were conducted in the laboratory under conditions practically duplicating actual service.

An audio-frequency amplifying transformer of exceptionally good electrical design, with a four-to-one turn ratio, was used. The results obtained apply strictly to this particular make of audio-frequency transformer and therefore would not be found correct for all makes of such transformer. In general, however, the differences between the amplification obtained from the various tubes hold approximately true for other transformers of similar design and of the same general characteristics.

In Figure 1 a family of curves is shown. The vertical axis shows the audibility or current amplification. The horizontal axis shows the audio frequencies of the alternating-current voltages applied to the vacuum tubes and the audio-frequency amplifying transformer. In the test, the amplification and the frequency of the A. C. voltage applied to the grids of the amplifier were noted. The amplification, together with the particular frequency of the input current were plotted as the observation was made. A curve drawn through the points plotted indicates how the amount of amplification obtained is influenced by the varying frequencies applied to the grids of the various vacuum tubes indicated in combination with the audio-frequency amplifying transformer. The frequencies used in the experiments correspond to the basic range of frequencies produced in music and human speech.

At points where curvature appears the change in amplification noted is the direct result of the particular frequencies applied to the grids of the vacuum tubes. At these frequencies, tones emitted from loudspeakers and headphones operated by the transformer and vacuum tubes cannot correspond, in point of volume, to the original tone acting upon the microphone in a broadcasting station. This effect is known as "distortion," and appears wherever the output does not reproduce the input with fidelity.

To illustrate to what an extent an audio-frequency transformer of poor design may be held accountable for distortion, the characteristic curve of another transformer has been added, which appears as curve "D." Obviously a transformer that produces such an erratic characteristic would be unsuited to broadcast reception. Yet, a considerable number of such transformers are being offered to the public and enjoy a wide sale.

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From a photograph made for POPULAR RADIO

HOW THE TESTS WERE MADE

The author is here shown taking the measurements from which the data for the curves and tables in this article were made up. The curves were made by comparing a signal both before and after it has passed through the amplifier. The ratio of the two signals (or rather the ratio of the resistances used in balancing the two signals) is the amplification constant.

The ideal transformer would produce a straight line parallel to the frequency scale. Although the transformer used in these tests has a sloping characteristic below 600 cycles a second, at higher frequencies it produces practically uniform amplification. For this reason it is well suited to these measurements, as we are in quest of information on vacuum-tube performance.

In these measurements the amplification is expressed as "times audibility" and represents the number of times the telephone current has been multiplied in passing through the particular vacuum-tube and transformer-combination used.

In all curves shown in Figure 1, the voltage applied to the plates of the various vacuum tubes used was 67.5, a voltage most frequently specified by transformer manufacturers. The grids of all tubes tested were connected to the negative-filament terminal. This connection is standard with most amplifier and receiving-set manufacturers.

In the table on page 123 the results obtained from the curves in Figure I have been entered, together with some further information obtained by calculation. The theoretical energy amplification obtained with UV-201-a tubes has been made the standard of comparison, its value being expressed as 100 percent.

The sound volume delivered by headphones and loudspeakers is governed

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by the electric energy supplied to them. The current increase due to amplification, in itself is not a direct indication of the comparative sound output that either the headphone or the loudspeaker may be expected to produce. To determine the comparative sound volumes that may be produced by headphones or loudspeakers operated by various tube combinations, it is necessary to express the measured current or audibility increase as energy amplification, inasmuch as such devices are energy-operated.

The energy amplification may be assumed to vary as the square of the current amplification because the impedance of the load circuit was maintained constant as well as larger than the internal plate impedance of the vacuum tube. This assumption is quite correct, as the relative amplification values noted in the above table are taken along the flat portion of the characteristic and thus free from the influence of frequency changes.

The energy amplification computed in this manner is noted in column 3.

Column 4 shows the percentage output produced by the various tubes specified in terms of 201-a output. Column five shows the percent difference in output of such tubes in terms of the 201-a output.

From the observations noted in columns 3, 4 and 5, it will be seen that the WD-12 tube used as a single-stage audio-frequency amplifier delivers an energy output, equivalent, in round numbers, to 60 percent of the 201-a tube output, representing a 40 percent sacrifice in result. In the case of the 199, these figures become 73 and 27 respectively, representing a smaller sacrifice in result, namely, 27 percent.

Instead of using the percentages of column 4, let us refer to the energy amplifications listed in column 3.

Suppose we consider the electric energy fed to the amplifier by the detector as the energy unit. One stage of audio-frequency amplification would produce a sound volume 625 times larger than this unit with the 201-a tube; 550 times with the tube 201;* 460 times with tube 199 and 380 times with tube WD-12. These values differ considerably numerically on paper, yet the differences seem less impressive to the ears of the listener.

Two stages of audio-frequency amplification are more widely used by the listener and for this reason an appraisal of the dry-cell tube's performance in this field will perhaps prove of even greater interest. To carry these observations this further step forward, calculations are again necessary.

Amplifiers arranged in cascade amplify in geometric progression if the voltage applied to each of the grids falls within the straight portion of their grid-plate characteristic; that is, voltages whose values are below the bend in this characteristic. When so operated, the result produced by two stages of amplification "A" becomes the product "A x A." This relation applies to the amplification whether expressed as current or energy amplification. In either case the amplification for two stages is the product of the amplification of the

*The improvements in storage-battery-operated tubes are also clearly indicated. It is to be observed that tube 201-a produced a trifle less than 14 percent more energy amplification than the older 201 tube. This by itself is a considerable improvement but, when accomplished with one-fourth of the filament current formerly needed, represents a decided advance in the art of vacuum-tube manufacture.

FIGURE II

1	2	3	4	5	6	7	8	9
	ONE STAGE				TWO STAGES			
Tube	Current Ampli.	Energy Ampli.	% Output	% Diff.	Current Ampli.	Energy Ampli.	% Output	% Diff.
201-a	25	625	100	0	625	390,000	100	0
201	23.5	550	88	12	550	300,000	77	23
199	21.5	460	73	27	460	210,000	54	46
WD-12	19.5	380	61	39	380	144,000	37	63

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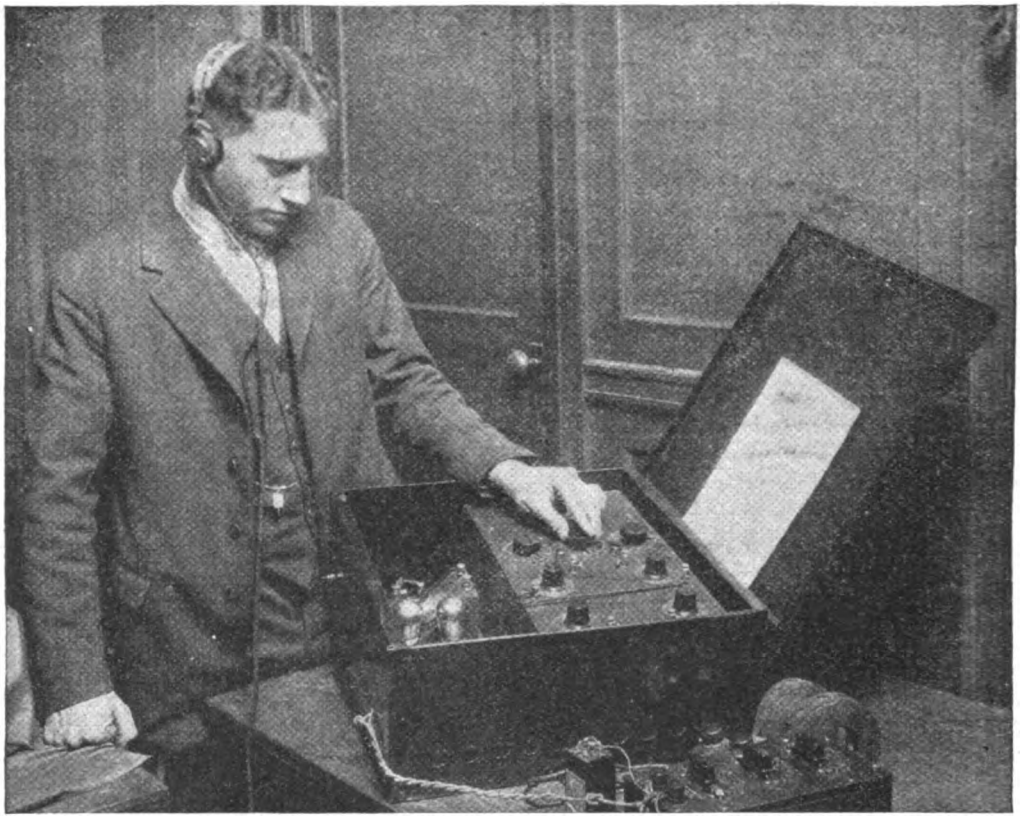

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ADJUSTING THE VACUUM-TUBE OSCILLATOR WHICH IS USED TO PRODUCE THE STANDARD SIGNAL FOR THE TEST

It is quite important that the signal follow a sine-wave curve and that its frequency be variable over the audible limits.

individual stages, however expressed, and if each stage produces the same amplification "A" the result of two stages is "A^2." In the case of three stages of audio-frequency amplification, were there no very serious practical limitations, the over-all amplification produced would correspond to the third power of the amplification of the individual stage, equal amplification, of course, being obtained from each of the stages.

This geometric relation which governs the operation of the cascade amplifier is of the greatest significance, and yet it is little known to the radio listener.

Vacuum tubes are rated in terms of their individual performance, but their operation in the cascade arrangement leads to results of a different order. Differences noted in their individual performance, which may be quite small, assume astonishing proportions in the cascade arrangement.

It may be of some interest to note how the action of the cascade arrangement would differ if it obeyed arithmetical instead of geometrical law. The case, it should be remembered, is purely hypothetical and except for purposes of illustration, it has no value whatever. Were the amplification arithmetical, two such stages of amplification would equal the sum of the individual amplification of the two stages. The values of columns 6 and 7 would be

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only twice as large as the values of columns 2 and 3. A far greater number of tubes would be required to produce the amplification values noted in columns 6 and 7. The percentages noted in columns 8 and 9 would not, however, differ from those of columns 4 and 5.

Take the 199 tube as an example: This tube was 73 percent as effective as the 201-a tube. It produced 165 less energy units than the 201-a tube. Two such stages of amplification obeying arithmetical law would lack another 165 energy units, reaching a total of 330 units. This would, however, still be equal to 73 percent of the amplification produced by two 201-a tubes.

Actually, however, because the over-all amplification is the product and not the sum of the individual amplification of each tube, the resultant amplification becomes .73 x .73, or 54 percent.

Referring to Table 2, we find two stages of 199 and WD-12 are, respectively, 54 percent and 37 percent as effective as two stages of 201-a amplification. The comparative loss or sacrifice in volume for two stages of 199 and WD-12 becomes 46 percent and 63 percent, respectively. Differences in performance of this order, which are enormous indeed, account in large measure for whatever disappointments listeners experience in their use of the dry-cell tubes.

These differences may be more strikingly illustrated by referring to column 7 of Table 2. Here the over-all, calculated energy amplification has been entered. Also in this case consider the energy fed to the first amplifier tube as the unit. We find that if two 201 tubes replace 201-a tubes of like number, the energy is increased 300,000 fold. For two 199 tubes, 210,000 fold, and WD-12 tubes, 144,000 fold.

Now with two 201-a tubes an amplification of 390,000 fold was noted. If we consider the loss of energy units, it is to be noted 90,000 units less are obtained with 201 tubes;* 180,000 less with 199 tubes, and 246,000 less with WD-12 tubes.

From the data obtained it must be apparent that when cost is weighed against results, the use of the dry-cell tube as a single-stage, audio-frequency amplifier *is* wise economy.

However, weighing cost against results, the dry-cell tubes used in the amplifier of two stages do not, in the opinion of many, represent real economy. Considering the investment represented by the receiving set, two-stage amplifier, vacuum tubes, loud-speaker and sundry accessories, the added storage-battery and charger cost is not prohibitive, particularly as each of these units is so much less effective when dry-cell tubes are used.

It should be noted, however, that the two-stage amplifier that uses dry-cell tubes produces an amplification many times greater than the amplification of the single-stage amplifier using the larger tubes. When it is considered that the two-stage amplifier fitted with dry-cell tubes costs less than a single-stage amplifier that uses the larger tube provided with its complement of storage battery and charger, the former has much in its favor. Do not, however, look for performance approaching the two-stage amplifier fitted with storage battery tubes.

*Here it is to be observed that the two-stage audio-frequency amplifier using 201-a tubes produces 30 percent more energy amplification than the older 201 tubes.

How to Build an Amateur Transmitter

In the coming issue of POPULAR RADIO—*for March—Laurence M. Cockaday will describe how to build a CW transmitter at a total cost for parts of not more than $70.00.*

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From a photograph made for POPULAR RADIO

THE AUTHOR DEMONSTRATES HOW HE FOLLOWS THE HOOK-UP DIAGRAMS

Although he was born sightless, Mr. Hughbanks has made a record of accomplishment as a lecturer, scientist and as a member of the Kansas Legislature of which any man may be proud. And among these accomplishments is his remarkable ability to build his own radio apparatus from published instructions.

How I Learned to Build My Radio Sets Without My Eyes

It is my purpose in this brief article to give to the readers of POPULAR RADIO, some idea of the methods I have employed as a sightless man, to gain a working knowledge of the art of radio, and how I learned step by step to overcome the difficulties which confronted me in the construction of my apparatus.

By LEROY HUGHBANKS

FROM my earliest boyhood I have been interested in the study of the natural sciences, especially physics, chemistry and astronomy. I was very fortunate at this period to have a teacher of serious scientific attainments; he was an inspiration to me. Every hour which was not demanded for my regular lessons I devoted to the study of the sciences, not only in the grades but in the high school and college.

The subject of radio communication was just being talked about by a few intelligent people about the time when I began my early scientific studies. There was so little published on the subject, however, that I knew of it only as a minor branch of electrical science.

My first step in the study of this vast subject was to learn the terms used in the subject and gain some knowledge of the theory and practice of radio transmission and reception. This, of course, took considerable reading, and as there are no books on the subject in the embossed systems of printing used

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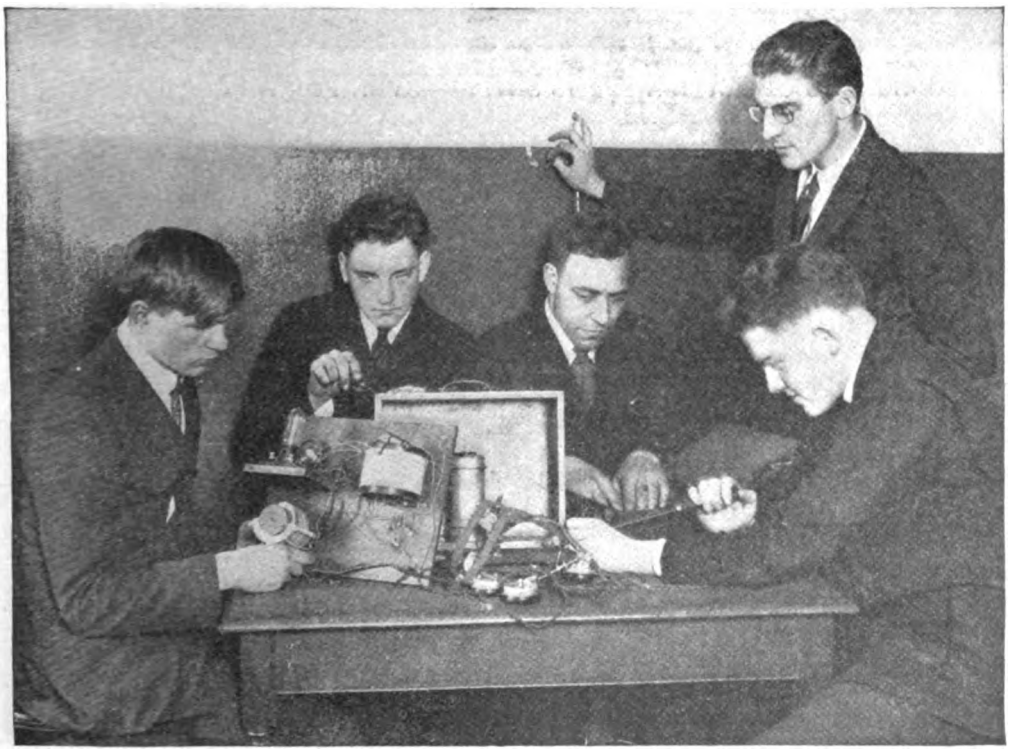
by the blind, I had to have all this matter read to me. Fortunately I have a sister who has acted as my secretary for years. It was but natural that my interests should be kindled further when the great radio wave swept the country during the fall and winter of 1921 and 1922.

I decided that I wanted to learn to construct my own apparatus—at least to learn to assemble parts. This brought about new problems. Chief among them was to find some works on radio that would give explanations in full without resorting to diagrams. This I found was impossible.

My first step, then, was to solve the diagram problem. This is how I did it.

I sought out a bright young radio experimenter in my town and had him draw me a diagram on a thick sheet of paper—a diagram that could be felt with the fingers. The first diagram that my young helper made was that of a simple crystal receiver, but I could read it with my fingers. This lad had a crystal set of his own, and I examined it thoroughly and in detail, learning the place and function of every connection. I had my helper make a crystal receiver for me, and I took it home and studied the construction of it, also I learned by reading and experimenting, why this set would receive, why a crystal would rectify and not amplify, and many other essentials.

As the next step I went to our broadcasting station here in Anthony and learned something about transmission.



Kadel & Herbert

WHERE BLIND BOYS ARE TAUGHT TO BUILD THEIR OWN RADIO SETS

For a person with eyes to complain of the difficulty of assemblying his own receiver seems almost like an admission of stupidity; students at the New York Institution for the Education of the Blind construct single-circuit regenerative receivers as part of their regular training.

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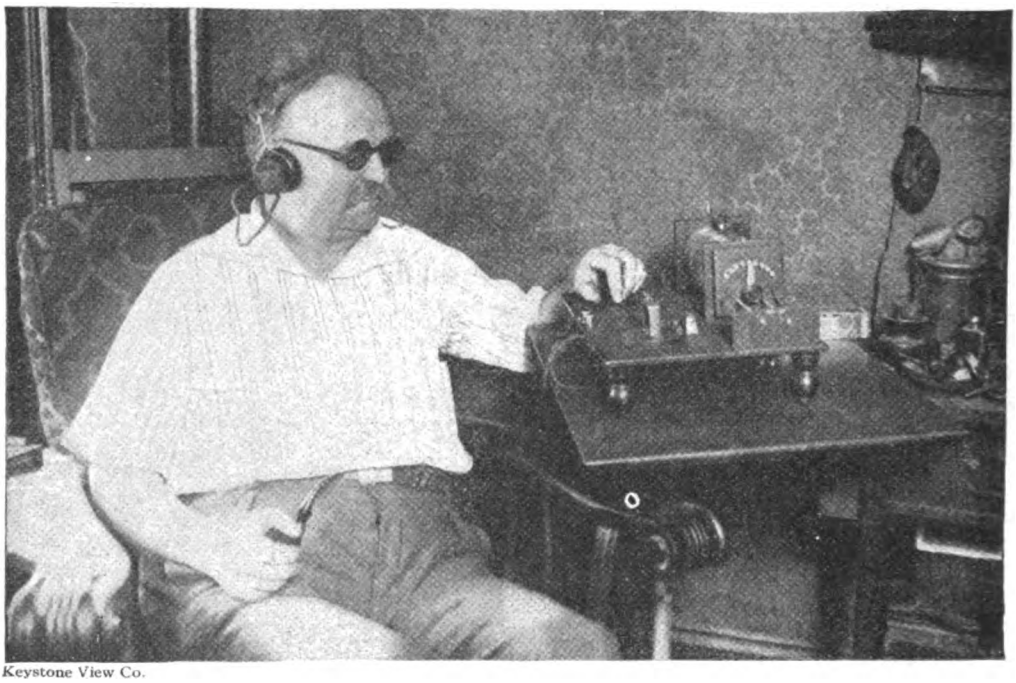

Keystone View Co.

MERELY TO OPERATE A SET IS SIMPLE—EVEN FOR A BLIND MAN

Radio is opening up a new and larger world to the sightless. The fan pictured above is a former New York police officer who lost his eyes in line of duty; he is one of thousands of blind men to whom radio comes as a godsend.

In the meantime I kept on reading and did not hurry to start the assembling of a tube receiver; neither did I allow my family to purchase a good tube outfit which they offered to do. I wanted to consruct it myself and to know the whys and wherefores of it.

A complete solution to the diagram problem had not yet been found. Radio was a new subject to us all and the literature on the subject with the conflicting opinions of hundreds came pouring in every week. I really had a problem not only for myself but for all blind folks, and I wanted to solve it. I think I have done so. Once before I had had a similar one and that was in the study of Greek in college; the point for me to solve at that time was how English symbols were to be used to impart Greek meanings. Similarly, my problem in radio diagram was how to change a drawing, composed of lines and symbols, to a word picture that would be intelligible to a blind man who could not refer to such a picture.

My young helper and I got together and turned the trick so successfully that even the most intricate diagrams now come within my understanding.

To be brief, the method is this: The person who gives this diagram to me must know the main features of a radio circuit and understand what the symbols stand for. He merely translates these symbols into words. For example, take the symbol for antenna on the diagram; when my helper says "from the antenna binding post to connection No. 1 of the primary of the variocoupler," I would simply write. "From A. B P. to con. No. 1 of V C."

At first I spelled the words out completely, but as I became familiar with radio terms I find this unnecessary and useless. I try to teach every one

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who gives diagrams to me to be orderly and not confuse the various portions of the circuit.

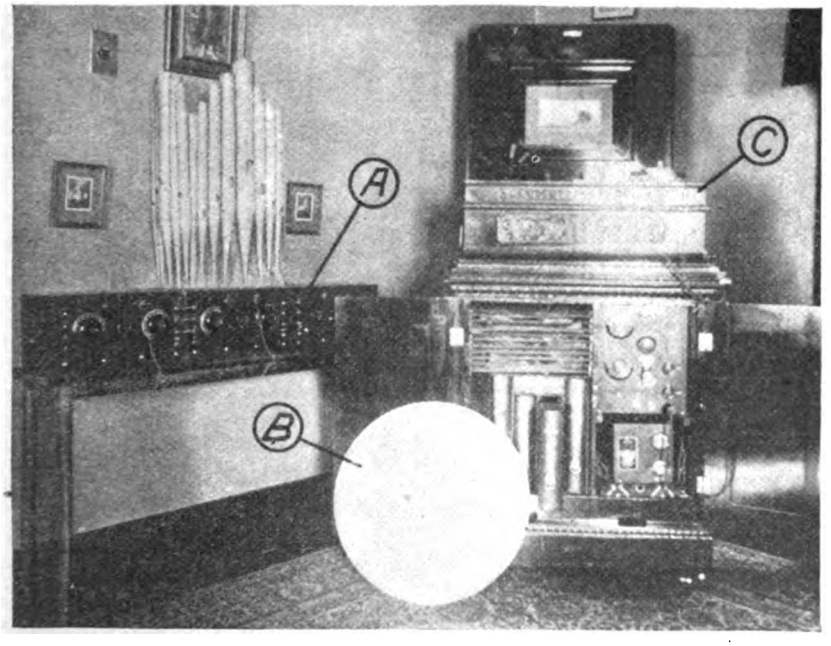
Take, for example, a single-tuned circuit, the antenna circuit, speaking in terms understood by all, is a separate part of the wiring diagram and it can be given in order, step by step, from the antenna binding post to the grid of the detector tube.

I do not feel that the blind have yet recognized what radio can and will mean to them. Many of our blind young men in our schools are taught mechanical trades — broom making, manual training and piano tuning, for instance. These men should be able, with a little help, to assemble their own radio receivers.

Many people ask me just how I do these things. I have but one answer: I master my circuit to the utmost and use apparatus that is easily handled and trustworthy. I keep in mind, for instance, that a positive "B" battery connection should never come near the "A" battery connections; the blowing out of expensive tubes is unnecessary. I find it advisable to use a tube socket with raised symbols; in this way it is a very simple matter to tell the positive, negative, grid and plate terminals from each other. I try out new circuits, use all manner of tubes in the same set, and change battery connections to accommodate the various types of tubes, and I do this alone. Up to this writing I have never blown a tube on an apparatus which I have constructed.

Some people have asked me if all of my sets work. They all do.

Radio has been a godsend to the blind, and particularly to those of us who, after leaving college or going into business, are called back to rural communities.



CANNED RADIO WHEN YOU WANT IT

This ingenious outfit, constructed by Mr. C. H. Hewitt, allows good programs to be saved when they come in and played over as many times as desired. A is a sensitive receiver that employs both radio and audio-frequency amplification; B is the wax-disk record on which the programs are recorded, and C is a combination sound reproducer and recording phonograph.

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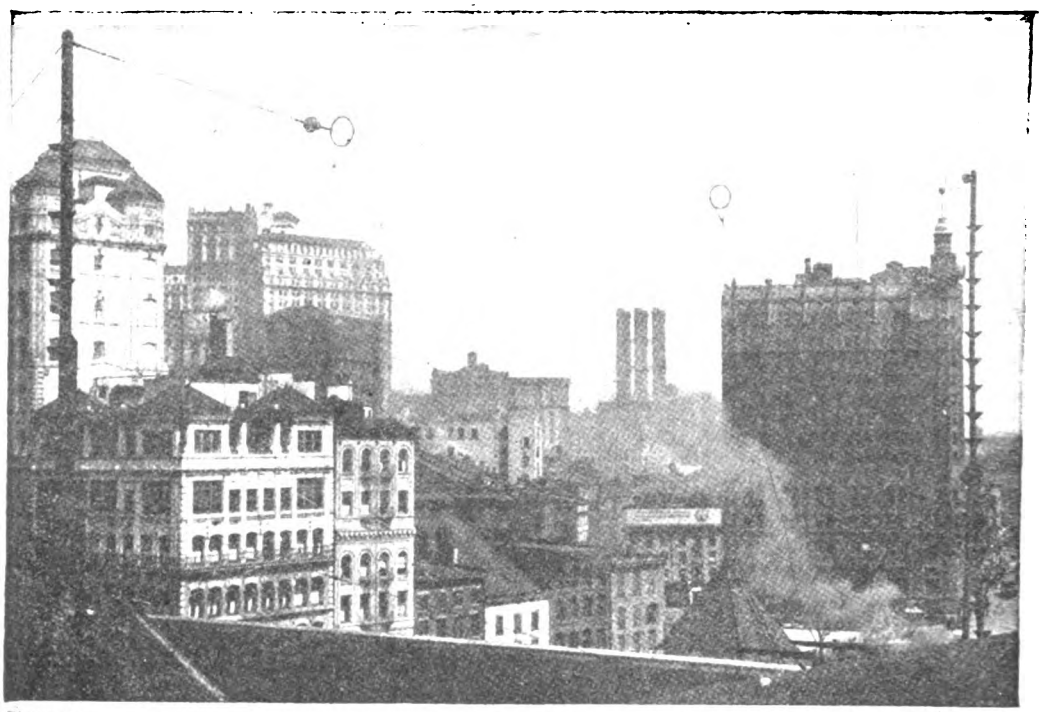

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PRACTICAL POINTERS FOR ELIMINATING INTERFERENCE IN

Long Distance Reception

An American amateur in Bermuda recently solved the problem of consistent DX reception even through the local interference from a powerful government spark station; he did it by means of tuned radio-frequency amplification and a directional wavetrap. Information concerning the circuits used, the wavetrap and the antenna equipment is here given in detail by the man who put up the receiving apparatus which was especially designed for reception of broadcast programs from stations scattered throughout the United States.

By ZEH BOUCK

THE permanent popularity of radio broadcasting is well evidenced in the American's *insistence* on this form of entertainment wherever he may roam. In recognition of this demand, Bermuda, 70 percent of the population of which is composed of American tourists, has taken up broadcast reception on a practical scale and the more progressive hotels there have installed receivers for the benefit of their guests. The writer personally supervised the installation of one of the first, and perhaps the most efficient installation on the islands.

Due to the distance from the States (some 700 miles) and the necessity of having a loudspeaker reception and other exacting requirements, there were numerous problems to be overcome before the set could be operated satisfactorily. The manner in which these difficulties were solved is of interest to broadcast enthusiasts, who desire to

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achieve the same excellent results with their own apparatus.

As the apparatus was installed primarily for the entertainment of visitors, it must first of all be capable of "delivering the goods" consistently. Signals were required of sufficient intensity to comfortably fill a good-sized music room.

The set must not be a Flewelling or conventional single-circuit tuner, or any other type of apparatus which radiates comparatively powerful continuous waves when the circuit is oscillating! (The British government is as emphatic on this point as our own government is lax.)

The apparatus must be of a design easily operated by one unfamiliar with the eccentricities of the more complicated radio circuits.

The installation must be capable of materially reducing the interference from the government station, BZB, operating a spark set on 450 and 600 meters *less than two miles away!*

During periods of heavy static, means must be provided for earphone reception of the news and stock reports which are daily posted on the radio bulletin board in the lobby of the Belmont Hotel.

The majority of these requirements rest greatly on the selection of apparatus, and were met in part, by deciding on a variocoupler two-variometer regenerative set of reliable manufacture. A set of this type combines remarkable selectivity, reducing the interference problem, with high efficiency and ease of operation. Using a good antenna and ground, with a single step of power amplification (in all, three stages of audio-frequency amplification) such a set gave powerful signals on a loudspeaker up to a distance of 500 miles over land, and at least double that distance over water. This installation, including a radio-frequency amplifier which ordinarily was not used, is shown in **Figure 1.**

The antenna system was of triple importance; several antennas were experimented with before results justified the expense of a permanent installation. A good antenna for ordinary reception was the least of our difficulties. The hotel is located on an elevation overlooking the picturesque Hamilton harbor, and a single wire strung from the tower of the hotel to a neighboring tree would furnish an antenna far superior to the average. However, taking directional possibilities into consideration (an important effect that is almost entirely ignored by the majority of enthusiasts) an antenna, 175 feet long, was swung from the hotel proper to the Casuarinas annex, running north and south, with a 50 foot lead-in taken from the northern end. While this did not give quite so efficient reception from the States as would an east to west, or southeast to northwest antenna (lead-in taken respectively from the west or northwest end), it furnished the greatest possible discrimination against the interfering signals from BZB two miles to the south. It was a compromise justified by results.

A smaller antenna, running east to west (lead-in taken from the west) was swung on insulators under the roof of the southern veranda. It was practically an indoor antenna, 25 feet above ground, having a total length, including lead-in, 75 feet long, and it was used with the radio-frequency amplifier. Due to the fact that the radio-frequency set, of the tuned-plate type, is an excellent factor in the elimination of interference, it was thought best, in this case, to avail ourselves to the greatest possible advantage from the directional possibilities of the smaller antenna. The loop shown in the illustration also played an important part in our receiving achievements.

The radio-frequency amplifier, as before mentioned, was not essential to loudspeaker reception under good conditions. At no time did it greatly increase the signal strength of stations

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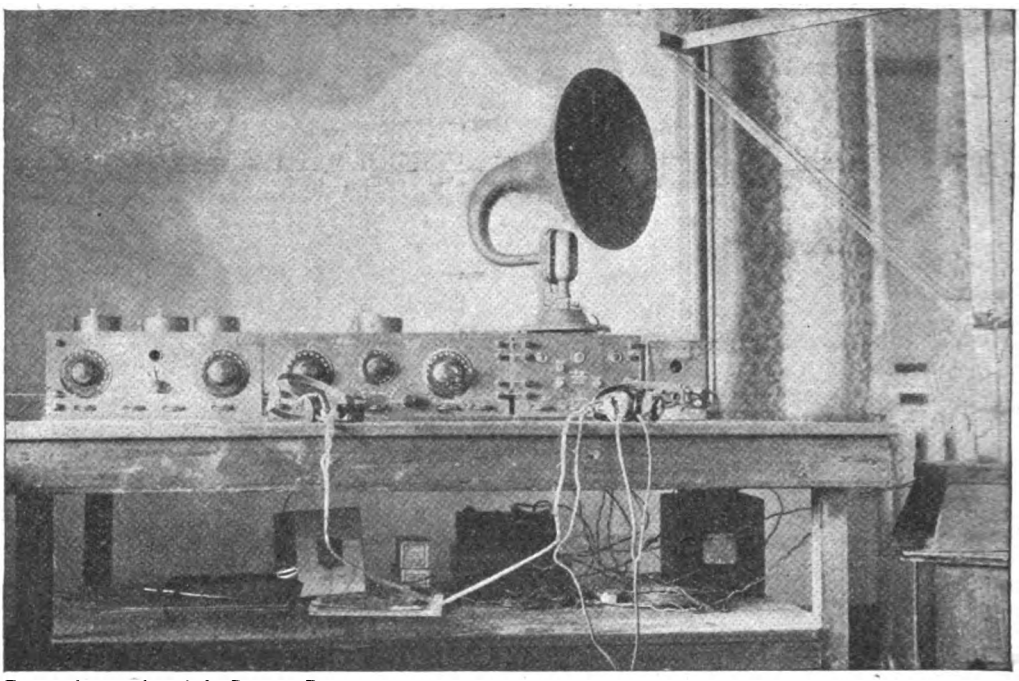

From a photograph made for POPULAR RADIO

THE COMPLETE RECEIVING INSTALLATION

FIGURE 1: *This set includes the tuned radio-frequency amplifier (on the table at the left), the twin-variometer, variocoupler tuner (center), the two-stage, audio-frequency amplifier (in the cabinet underneath the loudspeaker) and the single stage of power amplification (at the right). The edge of the directional loop-trap is shown in the upper right-hand corner of the photograph.*

on the Atlantic seaboard, and so, as it complicated tuning, it was eliminated except for the reception of stations over 1,000 miles distant (in which case this form of amplification was a great help), and on nights when 600-meter interference or static was particularly bothersome. In the first case, the radio-frequency amplifier was used in conjunction with one of the regular antennas, with the result that the QRM from the naval spark station was scarcely audible. In the case of heavy static, the loop antenna was brought into action, which, totally eliminating the "strays," enabled the operator to copy press and stock reports. Also, several of the nearer stations (6 to 700 miles) could be brought in with fair audibility on the loudspeaker. It was on loop reception that the radio-frequency amplifier proved its merit.

RADIO FREQUENCY

A radio-frequency amplifier of the tuned-plate type is not difficult to build, and, as a single stage is equal to two steps of the transformer-coupled design, it is economical in both construction and operation. The circuit is shown in Figure 2, which also indicates the preferred layout of the instruments in which various inductive and capacitative feed-back effects, disastrous in this system of amplification, are obviated. The condensers are shielded with twin plates (foil may be used) connected to each other and to the negative connection of the "B" battery. The shielding, as well as vernier adjustments on the condensers, not merely facilitate tuning, but it is indispensable to the most efficient operation of the set.

The condensers may be standard

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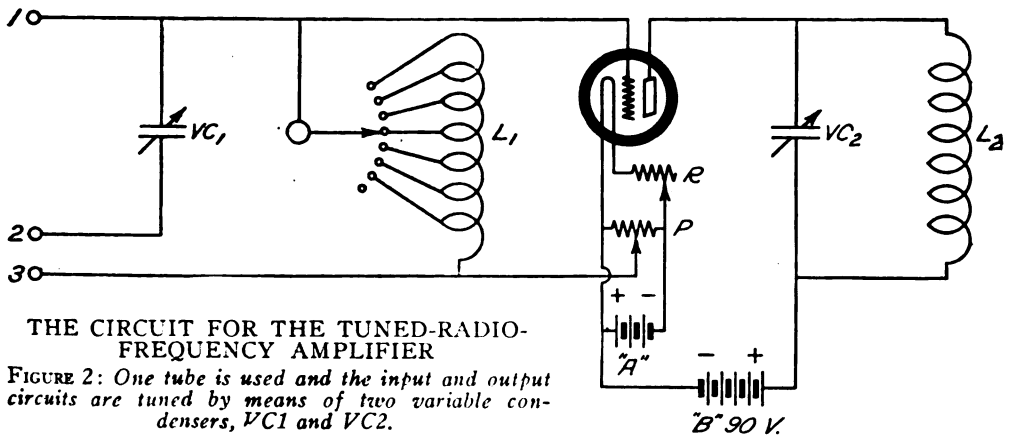
11-plate variables, mounted on opposite sides of the panel. The inductance, L1, is the primary of a variocoupler, or it may be made by winding 60 turns of No. 22 S.S.C. wire on a tube three and a half inches in diameter. The coil should be tapped every fifth turn, one tap (on the panel) being left *open* for loop reception. The binding posts, one, two, and three, are arranged so as to permit either loop-reception, condenser-shunted (posts one and two-three, the last two shorted) or antenna-ground reception with condenser-shunted (same connections as for loop) and antenna-ground reception with condenser in series (binding posts two and three).

Potentiometer R1, is a 200 to 400-ohm instrument. The tube should be a "hard" one, and the plate voltage in the neighborhood of 100 volts.

The output coil, L2, is an L-50 honeycomb coil, or a two-bank inductance with twenty-five surface turns (for broadcast reception). In operation, L2, is placed in inductive relation to the detector grid circuit, i.e., within three inches of the secondary of the tuner. In a three-coil honeycomb set, this is most easily accomplished by utilizing the primary (an L-50 coil) as the output winding; while in the case of the twin-variometer regenerative set, the output coil may be placed on top of the cabinet over the variocoupler (Figure 1). Hence the tuned-plate radio amplification is to be particularly recommended to the amateur who desires to add radio-frequency amplification without making any internal alterations in his present equipment.

In thus supplementing a single-circuit receiver, the tuned amplifier is doubly useful in that it effectually blocks whatever energy the receiver would ordinarily radiate when oscillating. However, the amplifier itself is a powerful oscillator when not properly stabilized by the adjustment of potentiometer R1. When the amplifier is in an oscillating state, it transfers energy not only to the antenna but also to the receiving set, where it is likely to be mistaken for the beat-note of a broadcasting station. For obvious reasons this should be avoided.

It was found that some experimentation with the antenna system was necessary in order to secure the best results with this method of intensification. Using the large antenna, reception was considerably improved, and tuning greatly simplified by eliminating the ground. This also reduced 600-meter and 450-meter interference. Using the shorter antenna *with* ground, while not affecting audibility, increased the distance which could be received. This was probably due to the more marked directional effect of the smaller antenna. Tuning, however, was more critical.



THE CIRCUIT FOR THE TUNED-RADIO-FREQUENCY AMPLIFIER

FIGURE 2: *One tube is used and the input and output circuits are tuned by means of two variable condensers, VC1 and VC2.*

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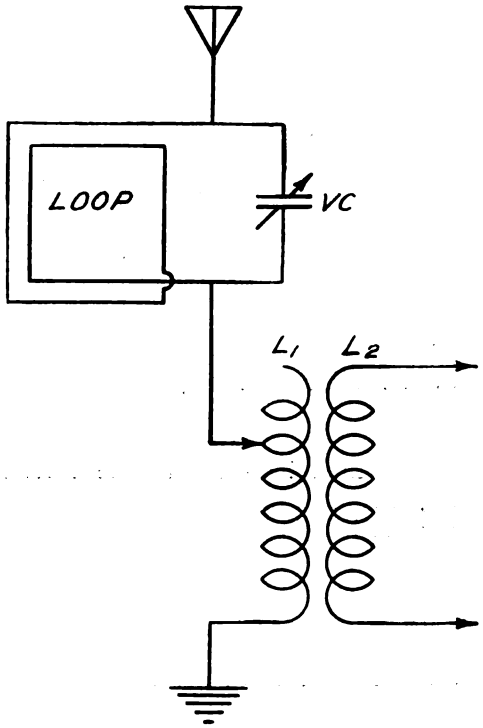

THE DIRECTIONAL WAVETRAP

FIGURE 3: *How the loop and the variable condenser are included in the antenna circuit to effectively cut down local interference.*

The best results of all were obtained using both antennas and no ground, the smaller antenna being employed as a counterpoise!

The writer has hinted that tuning the radio-frequency amplifier is a delicate achievement, but by applying the following procedure, the knack is soon acquired.

Having turned the potentiometer completely to the right (or to the side connected to the negative "B" battery) the receiver proper is first adjusted, by means of the tickler or plate variometer, so that the circuit is oscillating on approximately the wave it is desired to receive. The dial of the antenna condenser, and the inductance switch are also set at the correct wavelength, or, if this is the initial attempt at tuning, at half their full values. Moving the output condenser slowly by means of the vernier adjustment from zero upwards, the grid variometer (variometer set) or secondary condenser (honeycomb set) is twirled back and forth until the squeal or beat-note of the incoming station is brought in at its greatest intensity. (No energy will be radiated during this procedure, as would be the case were the radio-frequency amplifier not in the circuit.) The antenna condenser and inductance switch are now varied, again increasing the intensity of the squeal to a still higher maximum. At this point a zero beat is effected (the pitch of the whistle lowered until it disappears) and local oscillations *just stopped* by turning back the regenerative control (tickler or plate variometer). Slight changes are next made on the variometers and condensers, after which the final adjustment is effected with the potentiometer, which is turned up to the point just below where the signals become distorted.

Although the above directions may appear complex, the difficulties will vanish during an evening's experimentation.

THE LOOP

The loop designed for broadcast reception with the foregoing amplifier was of the solenoid type, three feet square, and wound with nine turns of wire, spaced one half inch. Tuning with the loop is identical with the process just described, excepting that one edge of the loop is first pointed in the approximate direction of the transmitting station.

The loop is especially satisfactory for reception through heavy local interference and static. However, through further experimentation with the coil antenna, another system of interference prevention was evolved which the author has termed a "directional wavetrap." By means of this device forced oscillations from BZB were reduced without the corresponding great drop in signal intensity that accompanies straight loop reception.

The ordinary wavetrap is nothing more than an inductance shunted by a variable condenser, which, placed in

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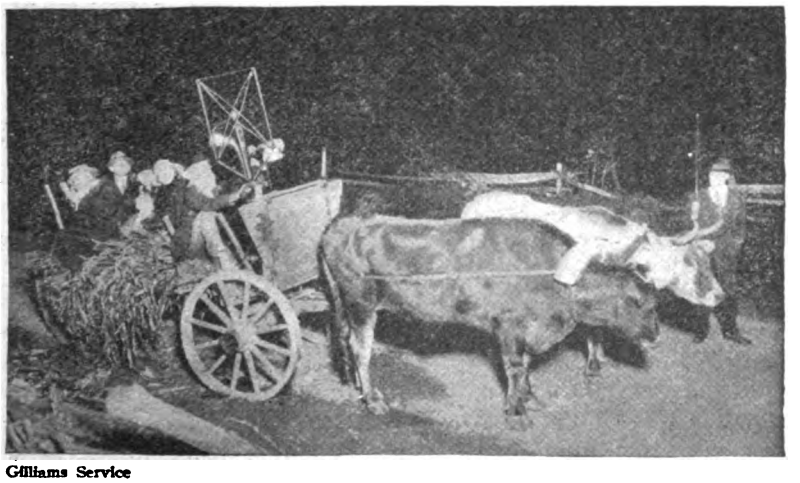
series with the antenna, absorbs certain frequencies or wavelengths which it is desired to eliminate. However, a wavetrap of the usual design, tuned to 600 meters, will absorb energy from nearby waves, so that the strength of signals within 200 or 300 meters of the resonant frequency will be decreased.

While endeavoring to strike a happy medium in wavetraps, whereby the naval interference would be considerably reduced without an unjustifiable drop in 360-meter intensity, it occurred to the writer to utilize the directional property of the loop, hoping, in some manner, to absorb still more of the interfering signal. Carrying out the idea, the loop, or more exactly four turns of it, replaced the coil in the conventional wavetrap. The cutting down of the number of turns was compensated for by an unusually large variable condenser (.002 mfd.) by which they were shunted, it being the approved procedure in wavetrap* design to reduce the inductance while increasing the capacity (re-establishing resonance) which permits the by-pass of the higher frequency (lower wave) currents.

This arrangement (Figure 3) was remarkably satisfactory, both from the standpoint of the elimination of BZB and the comparatively negligible effect on broadcasting. The fact that the degree of interference reduction varied considerably in accordance with which side of the loop was pointed toward the offending station, suggested the theory that the directional elimination is due to currents set up in the loop, exactly identical to those being received on the outdoor antenna, but differing from them in phase (when the coil is correctly pointed) by 180 degrees, and so tend to "buck" or nullify the received currents.

The directional wavetrap is apparently superior to the conventional trap only on nearby stations, where the counter oscillations set up in the loop are sufficiently powerful to affect the incoming signals. However, it can doubtless be used to an advantage by enthusiasts located within five miles of naval or commercial stations.

*Subsequent investigation has verified the theory of the directional trap suggested by the author, while also revealing the fact that this system has been known for some years, being employed in certain government sets during the war. Other experimenters have placed the loop-trap in series with the detecting grid circuit, bucking the oscillations in the secondary, in which position it is quite probable that the system will be effective for greater distances than those successfully experimented with by the writer.



Gilliams Service

A RADIO STRAW-RIDE

Entertainment need no longer be exclusively confined to amateur local talent on such old-fashioned rural dissipations as pictured above—at least not as long as a loop acrial and a loudspeaker will pick up the world's best broadcasting!

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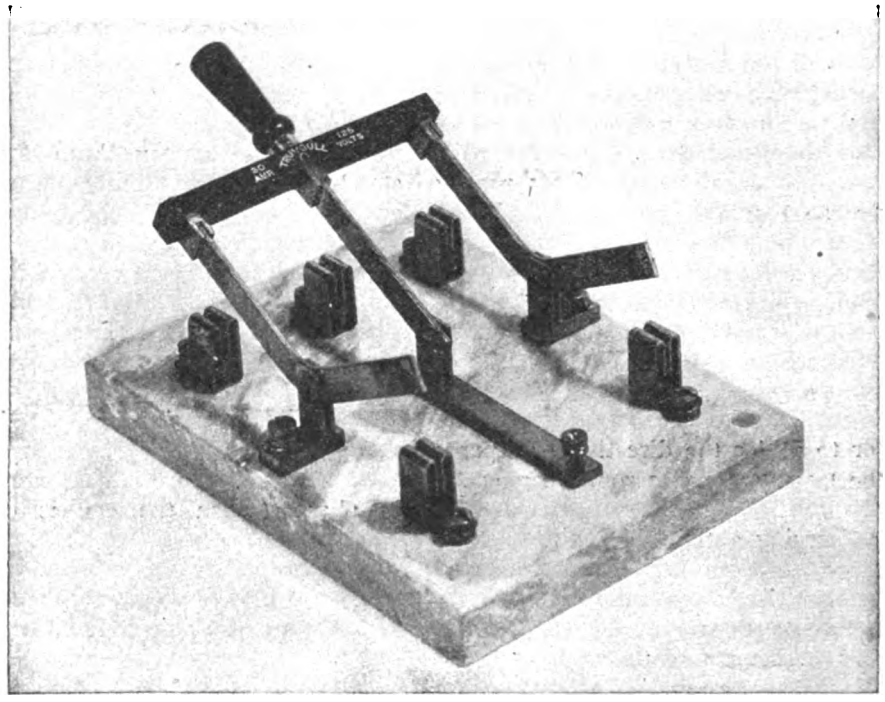

THE CHANGE-OVER SWITCH

This enables you to charge your battery or connect it to your receiving apparatus in a single operation.

HOW TO MAKE

A BATTERY-CHARGING PANEL

At a cost of about $20.00

Do you have to disconnect the wires from your battery to your set when you charge your battery? Did you ever accidently let the two wires short-circuit? Did you ever connect the positive to the negative by mistake? Is the necessary labor to disconnect and reconnect your battery-charging apparatus irksome? How to simplify these operations is told in this article by—

E. J. QUINBY, R. E.

HERE is a simple charging panel which makes it possible for the operator to put his battery on charge by merely pushing in one switch and, after the battery is charged up, to start his set going again by merely pulling out the same switch.

Moreover, in this charging panel provision is made for reading the voltage of the battery at all times by merely pushing a button, and for reading the specific gravity of the acid solution at any time by means of the hydrometer which is mounted in a handy position.

Many a good battery has been abused by overdischarging merely because a convenient means for charging the battery was lacking, and the much needed charge was repeatedly postponed until serious damage to the battery resulted. Every radio installation that requires the use of a storage battery should not be

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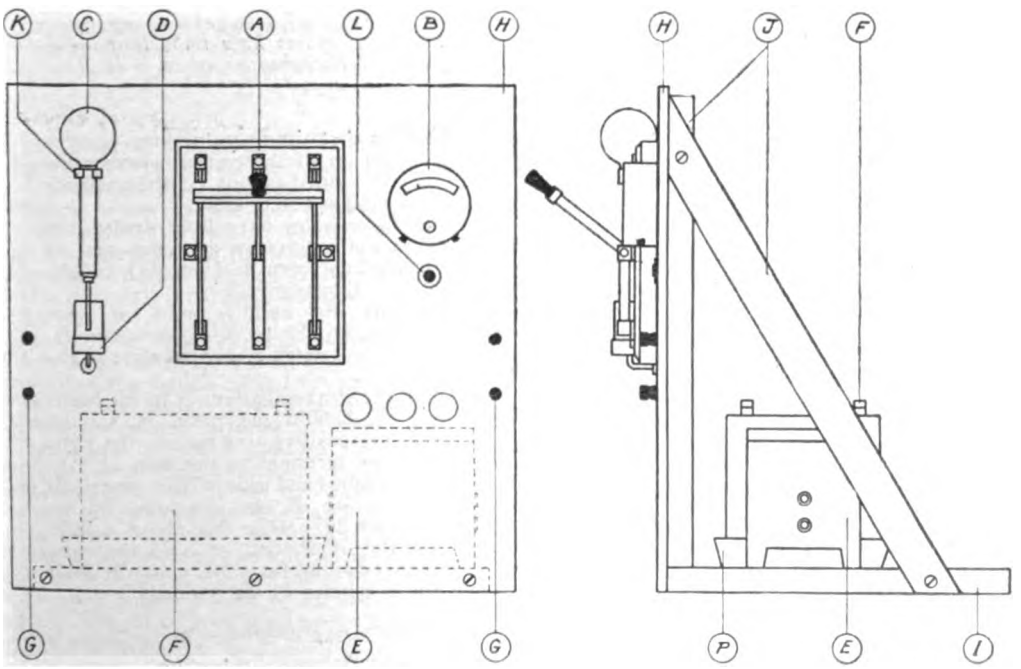
considered complete without some such device as is herein described.

This charging panel is equipped with a unique switch, which performs several duties at once. It was first designed to transfer from transmitting to receiving, or *vica-versa*. It is provided with two double-throw blades and one single-throw blade and it is mounted on an attractive marble base; furthermore, it passes the Underwriter's specifications for 125-volt service up to 30 amperes. This puts official approval on the scheme for connecting it into the domestic power supply for charging the storage battery.

The Parts Required

The parts required for building this charging panel, are listed below:

A—Trumbull triple-pole transfer switch (radio type);
B—storage-battery voltmeter, 0-6 volt or 0-10 volt range, panel type. (Weston, Westinghouse, General Electric or any other good make should be used);
C—Testright battery hydrometer syringe outfit;
D—drip glass and glass holder (an ordinary lavatory fixture may be employed).
E—a vacuum-tube battery charger or other types of battery chargers (which operate on the vibrator principle) may, of course, be used;
F—6-volt, 100 ampere-hour storage battery; any reliable make can be used;
G—binding posts, large insulated type; 4 are required;
H—front panel, 18 inches by 18 inches by ⅜ inch, three-ply board;
I—base, 12 inches by 16 inches by ⅞ inch plank;
J—braces, 1 inch by 2 inches by 20 inches long, pine, cypress, oak, or any strong wood; 4 are required. (Vertical pair will be 18 inches);
K—brass clip (for holding hydrometer); this may be made from strip brass, or it may be purchased at any hardware store;
L—push-button, as is used on door bells;
M—30 feet of No. 16 rubber-covered electric-light wire;
N—flat-head, brass wood screws, 1½ inches long; 12 are required;
O—½-pint can of black-asphaltum varnish;
P—hard-rubber tray (a photographer's developer tray will do.



THE FRONT AND SIDE VIEWS OF THE CHARGING PANEL

FIGURE 1: *This drawing shows in detail the layout for the various instruments: the charger, the battery, the change-over switch, the voltmeter, the hydrometer mounting and the drip cup.*

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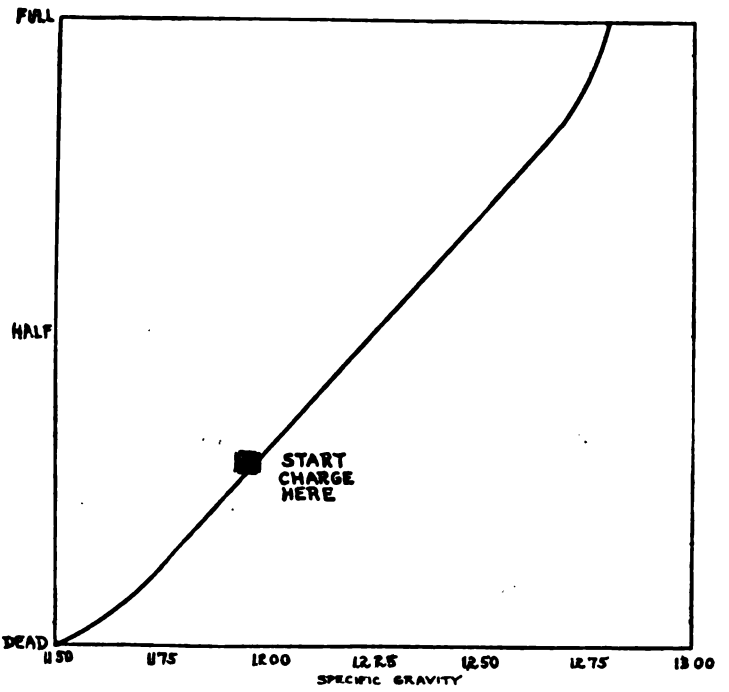

CURVE SHOWING CONDITION OF THE BATTERY DURING CHARGE

FIGURE 2: *It will be noticed that as the battery is put on charge, the specific gravity of the solution increases from 1,200 up to 1,250 (at half charge) and up to 1,275 (when the battery is fully charged). This curve shows how important the hydrometer is in determining when your battery needs charging or when it is charged enough.*

How to Assemble the Parts

When the experimenter has acquired all the items on this list, the panel, frame and base should be assembled.

First fasten the front panel H, to the two upright braces J, which should be located just one inch in from each edge. Three screws should be used for this purpose, on each brace.

Next, the back braces J should be attached to these front braces at the top, and run down to the sides of the base I, near the back, and secured with screws. The front panel H should be secured to the base I along the lower front edge with three screws.

Now trace around the edges of all the units to be mounted on the front of the panel H in their proper positions, and mark the locations of all holes to be drilled. Be sure to include the eight holes for wires to pass through the panel beside the eight terminals on the transfer switch A, two holes for wires to the voltmeter B, two holes for wires to the push-button L, and four holes for the binding posts G, two of which should be located near the center of the left-hand edge of the panel and the other two near the right-hand edge, directly opposite. Three holes about one inch in diameter should be drilled directly in front of the position occupied by the rectifier, so that the operator may observe (through the front of the panel) whether the rectifier bulb is lighted or not (if the vacuum-tube type of charger is used).

After all these holes have been drilled, the woodwork should be given a generous coat of the black-asphaltum varnish (item O) and be allowed to dry thoroughly.

Next, mount the various units in their proper positions on the front of the panel H. Be sure to set the switch A so that the switch-handle is *up*.

Now place the storage battery F in the hard-rubber tray P, behind the panel H, on the base I, with the positive terminal to the right and the negative terminal to the left.

Behind the right-hand side of the panel H, locate the rectifier E, as indicated in the diagram (Figure 2). Move this about, a little one way or the other, until it is in the most advantageous position for observing the bulb through the peepholes in the panel H.

How to Wire the Unit

Now the unit is ready for wiring.

It will be found that the kind of wire specified under item M is sufficiently rigid to retain its shape without any supports other than the terminals to which it is connected in the circuit. Make all connections as shown

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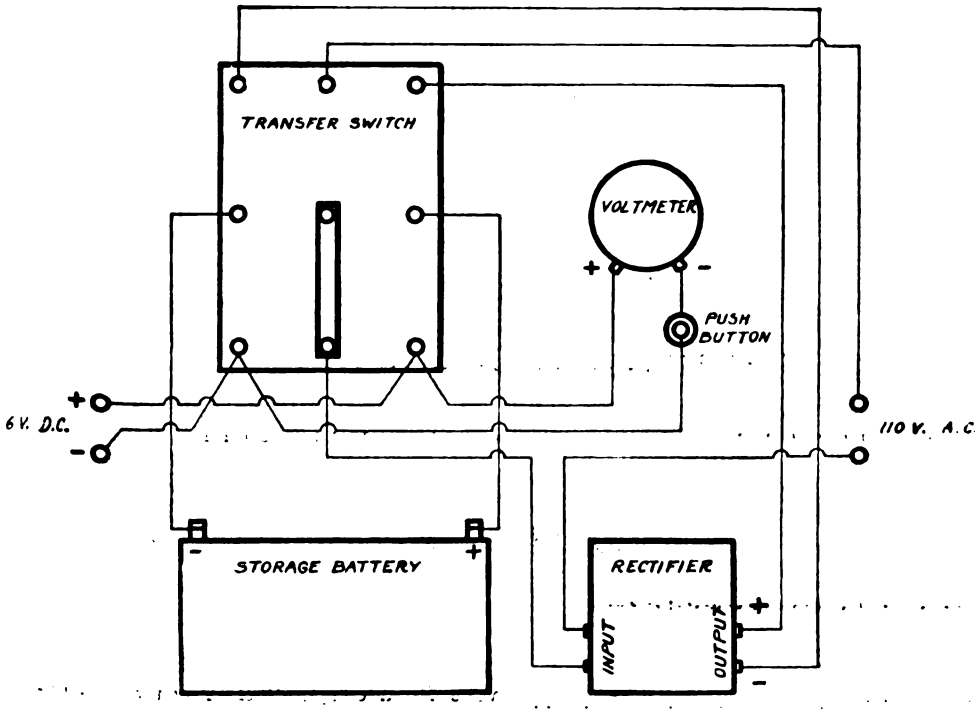

THE WIRING DIAGRAM FOR THE INSTRUMENTS

FIGURE 3: *By following the connections indicated in this schematic drawing you may be sure that your battery will always be connected with the correct polarity, whether you are charging it or using it to supply your set with the necessary current for lighting the filaments.*

in the diagram (Figure 4), running wires along rear of panel, and carefully check the work when the job is finished.

Be sure to see that the wire marked positive on the rectifier output, runs to the upper right-hand terminal of the switch A, and that the negative output wire of the rectifier goes to the upper left-hand terminal of the switch A.

The positive side of the storage battery F should be connected to the right-hand center terminal of the switch A, and the negative side of the storage battery should be connected to the left-hand center terminal of switch A.

The upper left-hand binding post on the panel H should be connected to the lower right-hand terminal of switch A, and also to one side of the voltmeter B.

The lower left-hand binding post on panel H should be connected to the lower left-hand terminal on switch A and also to one side of the push-button L; the other side of push-button L should be connected to the remaining side of voltmeter B.

The upper center terminal of switch A should be connected to upper right-hand binding post on panel H.

One side of rectifier input should be connected to lower right-hand binding post on panel H, and other side of rectifier input should be connected to lower center terminal of switch A.

This completes the wiring part of the job. All wires should be run straight and square, following the course shown in the diagram (Figure 4).

How to Operate the Panel

Locate the charging panel as close to the radio set as convenient and run a pair of wires from the 6-volt DC output, at the left of the panel, to the filament binding posts of the radio set; be sure to get the polarity right.

Next, connect the 110-volt AC line to the two binding posts at the right-hand side of the charging panel.

When the handle of the switch A is pushed in, the battery F is disconnected from the radio set, is reconnected to the output of the rectifier D, the same moment the rectifier E is connected to the 110-volt AC line; thus the process of charging the battery is begun.

During this charging process the specific gravity of the acid solution in the cells of the battery may be read from time to time, and a watch may be maintained on the progress of the charge in this manner.

A chart showing the relationship between the specific gravity of the acid solution and the charge, is shown in Figure 3.

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After expelling all the acid solution from the hydrometer syringe, it is returned to its position in the clip on the front of the charging panel, so that the lower end will set into the drip glass, thus avoiding any possibility of damage from this acid.

When the battery has reached a fully-charged condition, it is necessary merely to pull out the switch A—all the way out—and the battery F is at once disconnected from the rectifier E, and the rectifier is disconnected from the 110-volt AC line; at the same time the battery is connected once more to the radio set, without the irksome job of changing any wires.

Whenever it is desired to read the voltage of the battery F, set the switch A in the last position mentioned (handle all the way out) and then push the button L. At any time when it is desired to have the battery totally disconnected from the radio set and the rectifier also, the switch A may be set half way between the two extreme positions, so that the blades do not engage either set of jaws.

A pair of flexible wires with battery clips on each end may be kept handy, so that if desired the voltage of any single cell in the battery may be read separately from the others, by running these leads from the voltmeter to the cell desired. If the voltmeter reads backwards, it means that the connections are reversed.

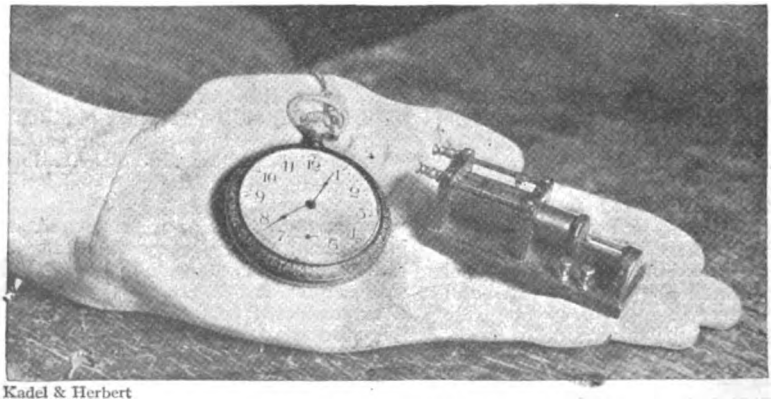
In charging a battery, the charge should be continued until the cells begin to "gas" freely (that is, to emit bubbles), and carried on for about one hour after this point has been reached. The little vent caps on top of each cell should be unscrewed and laid loosely on top of the opening during the charge; this prevents dust and dirt from entering the cells and at the same time avoids the possibility of confining the gas that is generated during a charge.

It should be remembered that the acid in the solution does not evaporate, but that the water in the battery solution does evaporate and requires replacement. Add sufficient distilled or approved water to each cell *before* commencing the charge, to cover the plates of the cells about a half inch.

When reading the specific gravity of the electrolyte in each cell of the battery, draw sufficient solution up into the hydrometer syringe to float the hydrometer clear of top and bottom, being sure to exert no pressure on the bulb while taking the reading. The figure at the level where the surface of the solution circles the hydrometer-float is the specific gravity. When the reading drops to about 1,195, the battery should be placed on charge. It should never be allowed to go below 1,150. A fully-charged battery should read about 1.280. An old battery will not quite come up to this figure on full charge.

Keep the top of the battery clean and wipe a thin coating of vaseline over all metal parts on the battery, including the terminals and connection bars. After charging and after replenishing the water in a battery, it is best to wipe off the top of the battery and all parts exposed to moisture, with a rag. A fully charged battery of three cells should read a little over 6.6 volts on the voltmeter. Near the end of the safe discharge period, the voltage (under load) will drop to about 5½ volts for a comparatively new three-cell battery. When near the danger point the voltage will drop off rapidly.

Dimensions have been avoided in describing this unit, so that the man who builds it will not be tied down to any particular devices or apparatus, but can use whatever equipment he has already purchased, together with a few extra parts needed to complete the job. The satisfaction obtained from good battery service will more than repay for the work required in building this appliance.



Kadel & Herbert

A MINIATURE LOOSE-COUPLER THE SIZE OF A WATCH

This baby tuner, made by M. W. Obermiller, covers the same broadcasting wavelength range as its larger brothers. It may be used with a crystal detector or with the more modern vacuum-tube detector. There are two sliders for the primary circuit and the secondary is tuned by means of a variable condenser.

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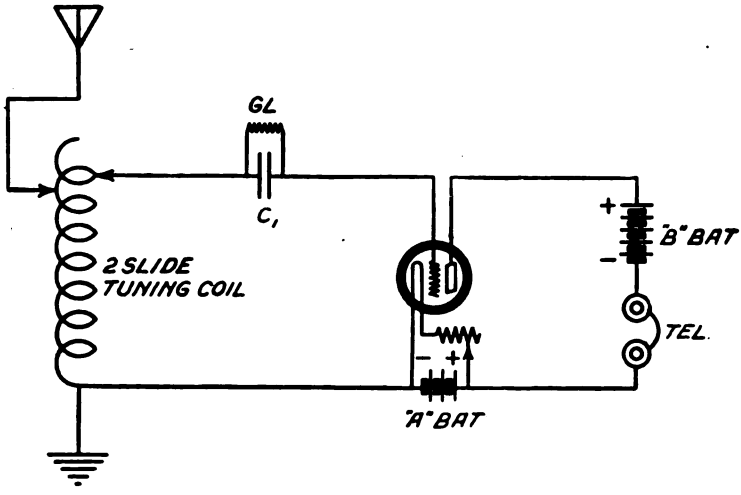

THE TWO-SLIDE TUNER, NON-REGENERATIVE CIRCUIT

Cost of parts: Not more than $13.00 *(Note:* The costs of tubes and batteries are considered "extras" and are not included in the costs given in these descriptions).

Selectivity: Fair.

Operation: An easy vacuum-tube circuit to tune. There is one slider for the antenna circuit and one for the secondary circuit. The only adjustment for the detector is the rheostat, which controls the brilliancy of the filament.

Ease of construction: Extremely simple.*

Approximate range: 100 miles.

Outstanding features: This is probably the next set for the beginner to build after he has experimented with the crystal receiver and found out how it works. This circuit will give good clear signals. It cannot re-radiate.

*(See POPULAR RADIO, October, 1922, page 148, for constructional details.)

100 BEST HOOK-UPS

INSTALLMENT NO. 4

IN this series of hook-ups is being published—for the special benefit of the radio novice who is undecided as to just what circuit he wants—100 of the best radio receiving circuits, each thoroughly tested. The approximate ranges given here are averages based on actual records made with receiving sets throughout the country. During the summer the actual ranges may fall to 50 percent of the value given, while in the winter, in the best of conditions, the actual ranges may exceed the values given by as much as 500 percent. All of these circuits have been described in detail in previous issues of POPULAR RADIO.

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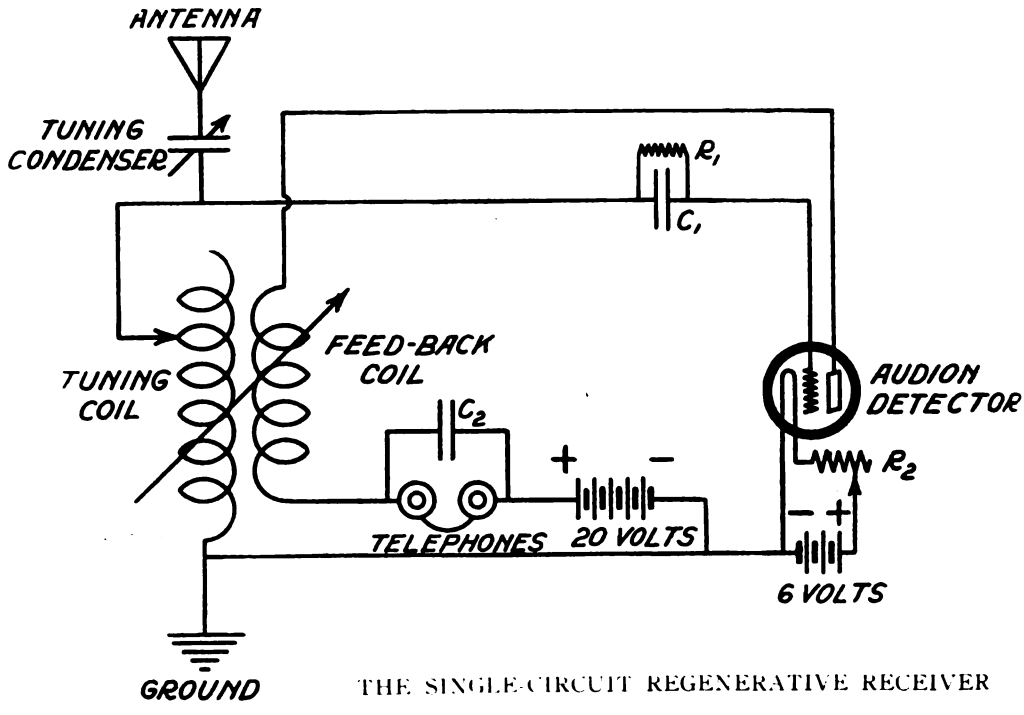


THE SINGLE-CIRCUIT REGENERATIVE RECEIVER

Cost of parts: Not more than $20.00.

Selectivity: Poor.

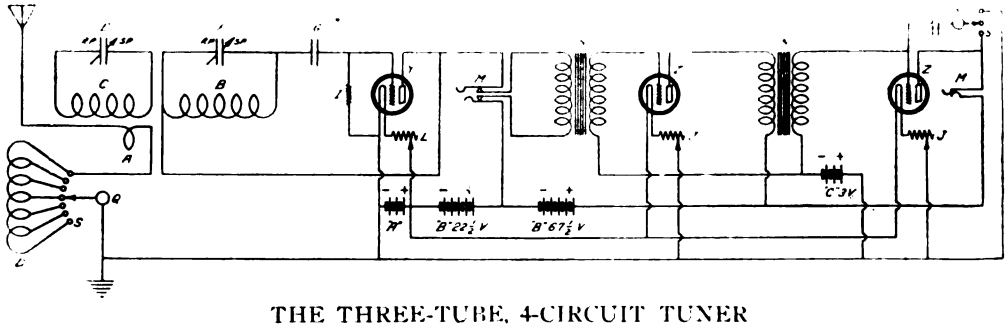
Operation: Simple.

Ease of construction: Not complicated.*

Approximate range: 500 miles.

Outstanding features: Easy to build and easy to operate; much simpler than most regenerative circuits. The great drawback to the use of this circuit, however, lies in the fact that it re-radiates strongly. In other words, while it is being used for receiving, it generates radio-frequency currents in the antenna system which cause radio waves to be sent out to produce interference in other receiving sets in the neighborhood. In the hands of an expert operator this might not happen but in the hands of an average radio fan it is almost sure to be the case.

(See POPULAR RADIO, November, 1922, page 192, for constructional details.)



THE THREE-TUBE, 4-CIRCUIT TUNER

Cost of parts: Not more than $40.00.

Selectivity: Excellent.

Operation: Very simple. There is one dial which controls the wavelength and one dial which controls regeneration. This dial can be set for the whole band of wavelengths over which regeneration will be constant.

Ease of construction: Not complicated. Be sure that the best parts are obtained, and the results will exceed expectations. Poor parts will render the circuit useless.*

Approximate range: 2,400 miles.

Outstanding features: Loudspeaker reception from distant broadcasting. Regeneration is independent of wavelength. Best sensitivity and selectivity.

(See POPULAR RADIO, May, 1923; also August, 1923, page 165, for constructional details.)

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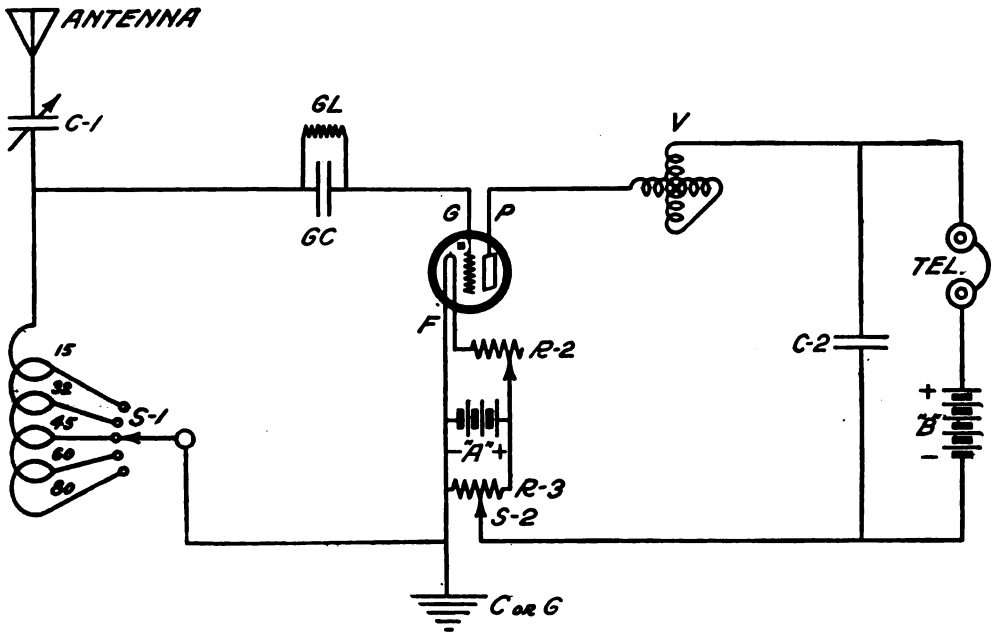
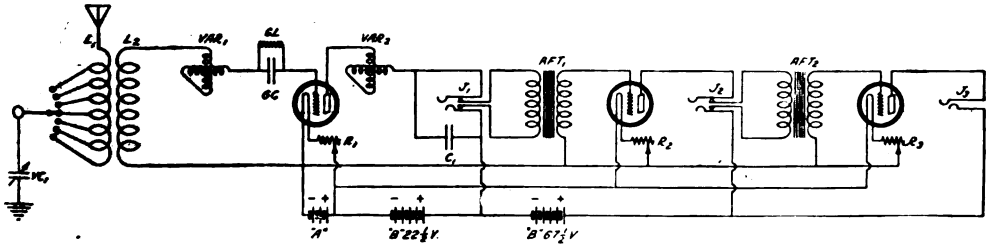


CONDUCTIVELY COUPLED, TUNED-PLATE, SINGLE-TUBE CIRCUIT

Cost of parts: Not more than $23.00.
Selectivity: Only fair.
Operation: Simple. A variable condenser is used for wavelength control and a variometer is used in the plate circuit to control regeneration.
Ease of construction: Not complicated.*
Approximate range: 500 miles.
Outstanding features: This modification will tune a little better than the straight single-circuit set, and can be kept in more stable operation by means of the potentiometer. The set is guilty, however, of permitting interfering re-radiation in the hands of the inexperienced operator.

*(See POPULAR RADIO, *June, 1923, page 430, for constructional details.)*



TWIN-VARIOMETER, VARIOCOUPLER REGENERATIVE CIRCUIT WITH TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts. Not more than $45.00.
Selectivity: Good.
Operation: Difficult.
Ease of construction: Just an ordinary acquaintance with tools and some ability in wiring up the circuit is necessary.*
Approximate range: 1,200 miles.
Outstanding features: All the tuning is inductive and this makes for louder signals, at a slight loss of selectivity. Both tuning and regeneration are controlled by variometers.

*(See POPULAR RADIO, *October, 1923, page 329, for constructional details.)*

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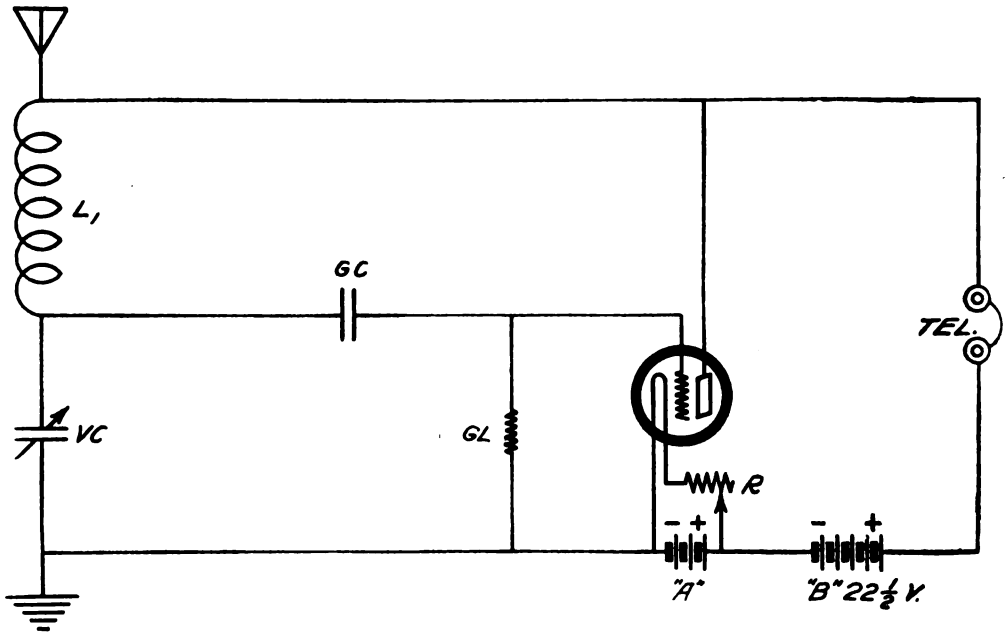
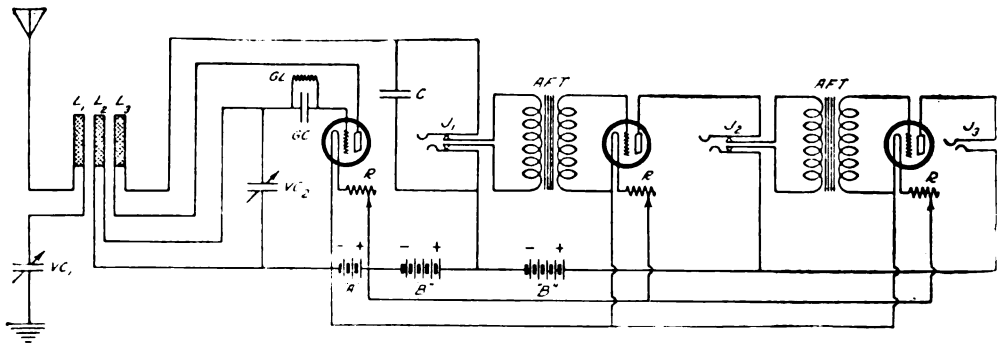


MODIFIED COLPITTS REGENERATIVE CIRCUIT

Cost of parts: Not more than $15.00.
Selectivity: Fair.
Operation: Extremely simple. There is one tuning control, a variable condenser, and the rheostat is used as a simple means to control regeneration.
Ease of construction: Very simple.*
Approximate range: 500 miles.
Outstanding feature: Simple to build and operate. It re-radiates.

*(See POPULAR RADIO, *October, 1923, page 329, for constructional details.)*



TRIPLE-COIL HONEYCOMB REGENERATIVE RECEIVER WITH TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $45.00.
Selectivity: Good.
Operation: Rather difficult to tune.
Ease of construction: The building of such a set is more difficult than the single-circuit tuner but better results in tuning will be worth the extra trouble, and the amplifier will make the set suitable for loudspeaker reception.*
Approximate range: 1,200 miles.
Outstanding feature: The set can be used for reception on any wavelength range by merely changing the size of coils.

*(See POPULAR RADIO, *April, 1923, page 308, for constructional details.)*

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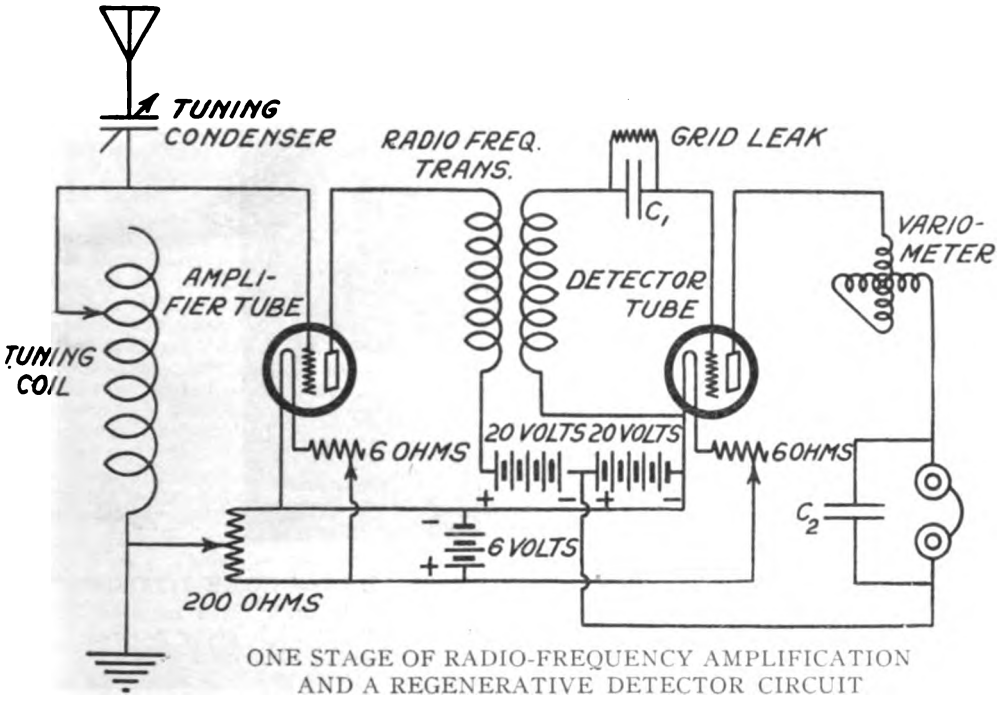
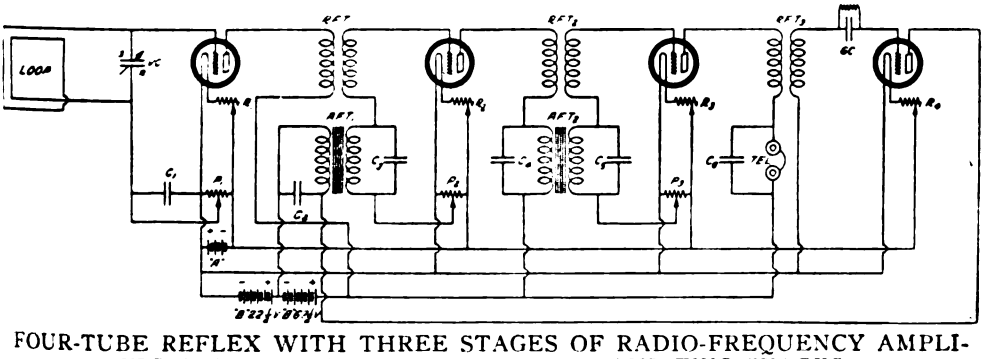


ONE STAGE OF RADIO-FREQUENCY AMPLIFICATION AND A REGENERATIVE DETECTOR CIRCUIT

Cost of parts: Not more than $40.00.
Selectivity: Good.
Operation: Fairly simple. The antenna tuning is done with a variable condenser and a tapped coil and regeneration is controlled in the two circuits by a potentiometer and a variometer.
Ease of construction: Just an ordinary acquaintance with tools and some ability in wiring up a circuit is necessary.*
Approximate range: 800 to 1,000 miles.
Outstanding features: Radio-frequency amplification gives clear reception even from distant stations and the regeneration used in combination helps in sensitivity.

*(See POPULAR RADIO, *November, 1922, page 104, for constructional details.)*



FOUR-TUBE REFLEX WITH THREE STAGES OF RADIO-FREQUENCY AMPLIFICATION, VACUUM-TUBE DETECTOR AND TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $60.00.
Selectivity: Excellent.
Operation: Very simple. Just one control for tuning—a variable condenser connected in shunt to the loop. Regeneration is controlled in the radio-frequency circuits by means of potentiometers.
Ease of construction: More or less complicated. There are a number of precautions that must be taken to get the circuit to function properly.*
Approximate range: 1,000 miles (on a loop antenna).
Outstanding features: No outdoor antenna needed for DX reception. Simplicity of tuning. No crystal detector to bother with.

*(See POPULAR RADIO, *November, 1923, page 418, for constructional details.)*

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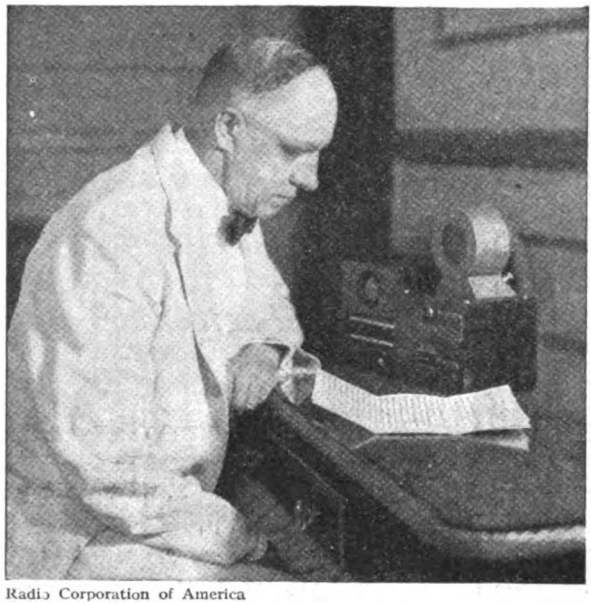

Radio Corporation of America

"CLASSES IN THE NORTH ATLANTIC STATES WILL NOW COME TO ORDER"

Such is the startling announcement that may conceivably be made when teachers broadcast their lectures to the schoolrooms within radio range. The above picture shows Mr. Frank A. Rexford, head of the Civics Department of the New York City High Schools, broadcasting a school lecture as part of a demonstration to illustrate the application of radio to the educational field.

Teaching School by Radio

An experiment in broadcasting that points the way to what may prove to be an extraordinary development in our scheme of education

By FRED SIEGEL

RADIO has been discovered again—this time by the educators. After watching this new medium of communication grow from a laboratory demonstration to a tremendous power, they concluded that there might be some place for this new science in the process of education. So they have been experimenting with it as a medium for disseminating education.

Specifically, the public schools of New York City have been experimenting with it.

The methods by which radio was introduced into the classroom are sufficiently novel to warrant the following report of the experiment, which was conducted at the Haaren High School in collaboration with broadcasting station WJZ:

The first demonstration was with a lesson in machine calculation, stenography and typewriting.

In the classroom was installed a receiving set; a similar installation was made at the Board of Education building.

In the classroom were installed thirty-five accounting machines; to each machine was assigned a student who had had one term of machine accounting. At the Board of Education, in the presence of the Board of Superintendents and other educators, was also installed an accounting machine with a student

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operator, while at the broadcasting station there was a similar accounting machine with a student operator, by whose work the dictator was to be guided.

(Incidentally in the classroom at the high school were also four students from the stenography and typewriting department who took the speeches that were transmitted before the lesson began; these speeches were copied, transcribed and delivered to the Board of Education, before the speakers reached that place an hour later.)

A teacher conducted the lesson in machine accounting. Before he dictated the problems he explained to those who were listening in that the work of the day involved the four fundamental processes of addition, subtraction, multiplication and division, and that the student operators were trained to work by the touch system and could devote their time to listening and thinking about the problems, rather than to the operation of the machines.

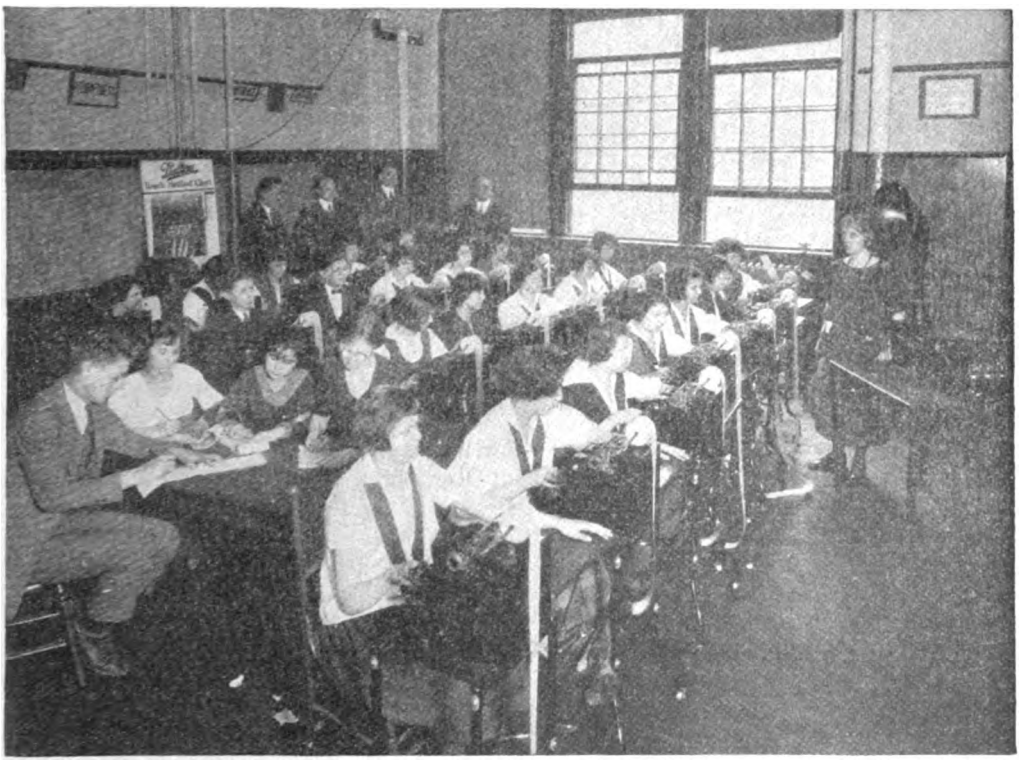
Then the lesson began.

The problem was dictated. Then there was a pause, in order to allow the operators to do the work. Then the answer was given. Each step in the computation of the problem was shown on the tape which the machine printed. A visible record was made of pupils' reactions; those who did not get correct answers were given personal attention after the lesson to correct any deficiencies in the knowledge.

The results of the experiment proved that the class in machine accounting heard, understood, and did the work as well as they would have done if the instructor were present in the room during the dictation. One girl made a record of 95 percent on the test.

Several weeks later a series of four other demonstrations of "education by radio" was held. The first was a model lesson in economics, and was conducted in regular classroom fashion. If every school within a radius of 500 miles had had a receiving set, the pupils and instructors in each of these schools could have heard how the subject was taught; they could have heard the questions propounded by the instructor and the responses of the pupils. The demonstration was considered an excellent one from every point of view.

The second experiment, held the following week, was a history lesson which was given to show an out-of-the-ordinary method of conducting a history recitation. In this in-



Radio Corporation of America

WORKING OUT PROBLEMS THAT COME INTO THE CLASSROOM BY RADIO

Thirty-five accounting machines were used by as many students in this classroom of the Haaren High School in New York for solving problems in machine accounting that were propounded by the instructor via station WJZ. In this manner classes could be conducted throughout the schools of a large area.

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stance, as in the previous experiments, the class was present in front of the microphone. At the beginning of the lesson the teacher distributed slips of paper to the class. He then proposed ten questions, each of which could be answered "yes" or "no." As each question was read the pupil wrote either "yes" or "no" on his paper. After the questions had all been dictated the discussion began.

"Mr. X how did you answer the first question?"

Mr. X had answered "yes."

"Why did you answer 'yes'?"

Mr. X had to defend his stand. Mr. Y had answered "no"; he took exception to some of the statements of Mr. X. So the discussion began, with the instructor acting as umpire. The recitation did not revolve about the instructor but was in fact a recitation in which every member of the class took part. The demonstration was of value to every teacher and pupil who listened in; it would have been of inestimable value to the teachers and scholars in the smaller schools throughout the east.

The third demonstration was a shorthand and typewriting contest in which six high schools entered. The matter that was dictated was new to the contestants and of moderate difficulty. There were two tests, one of eighty words a minute for the less advanced students, and one at one hundred words a minute for the more advanced students. Each test was three minutes long. Before the test began there was a short practice dictation for all of the students to accustom themselves to dictation by radio. The winner of the 80-word contest had but three errors, as did the winner of the 100-word. These demonstrations show the possibilities of the uses of radio for the giving of controlled tests of all types, as the students were in widely scattered places, yet each received the dictation under the same conditions. Such practice for students in all of the schools of a large territory could thus be handled by one teacher, dictating from the broadcasting station, while the transcripts of these practice dictations could be corrected by the students themselves under the guidance of one of their own instructors.

The fourth experiment was a lesson in Community Civics. The teacher concluded his lesson with an assignment of work for class the next day. In this demonstration we have an interesting instance of how the educational head of a large group could direct the work of the teachers and pupils in his particular subject over a wide area. In this case the broad general viewpoint was presented, with suggestions for further study, new developments were explained and the background was secured upon which the class teacher could build and amplify to meet the needs of his own group of students.

Interesting as these demonstrations have been, the real significance of them lies in the broader application of radio to our educational system—an application so broad, indeed, as to foreshadow a change in our present-day conception of what "education" really means. For example:

Training for citizenship forms an important part of the public school curriculum. The functions of the governmental agencies can best be described by those engaged in their performance. First-hand information is valuable and inspiring, but it would be physically impossible for the Governor (for example) to visit every schoolhouse in the state and describe the work of his office. This information is, of course, embalmed in text books and it is duly studied in all the schools, but how much more meaning would this information have if the sound of the Governor's voice penetrated the schoolroom, and in his own way he told of his problems and the work of the state?

It would not be at all impossible to induce the Governor to give an occasional talk to the school children of an entire state, or to induce other department heads to explain their activities. In this way the work of the teacher would be given more value and the pupil would be getting his information and inspiration from living sources.

The whole world could be his faculty! The schools in our larger cities are often honored with the presence of distinguished visitors, both from our own country and from abroad. The pupils in these schools are assembled to hear what these visitors have to say. But how many children can hear them? Only a room full. How much better would it be if these addresses could be broadcast to all of the children within the range of the sending station! In this way there would enter into the Little Red Schoolhouse the world's commanding figures in education, in science, in art and in statesmanship.

The teachers in rural schools are usually young people without much experience as teachers, with even less training for their jobs than has the average teacher in city schools. The quantity

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Radio Corporation of America

HOW THE SCHOOL TEACHER BROADCASTS HIS "RECITATIONS"

In the headquarters of the Board of Education in New York the instructor propounded school problems before the microphone that carried his voice by wire to station WJZ, where it was broadcast. The problems were also worked out by students in the instructor's office; these students served as guides for the time required to complete the answers.

as well as quality of their teaching should be the best possible. Any instrument, or device which would aid in attaining this end is a great asset to the school and the community. Radio can enter here as a factor laden with unlimited possibilities.

It is not inconceivable that the state may in time have its broadcasting stations, and that each schoolhouse may be equipped with a receiver. The staffs at the broadcasting stations may consist of experts who may work out courses of study which would be printed and distributed to the various schools. Quiz questions and suggested readings could be supplied; at stated periods the classes with the teachers in charge might gather in front of the receiving set and listen to the lesson, as presented by the instructor from the broadcasting station. After the lesson has been presented and fully covered, the follow-up work in the shape of written exercises or oral examinations could be conducted by the class teacher. In this way, it would be pos-

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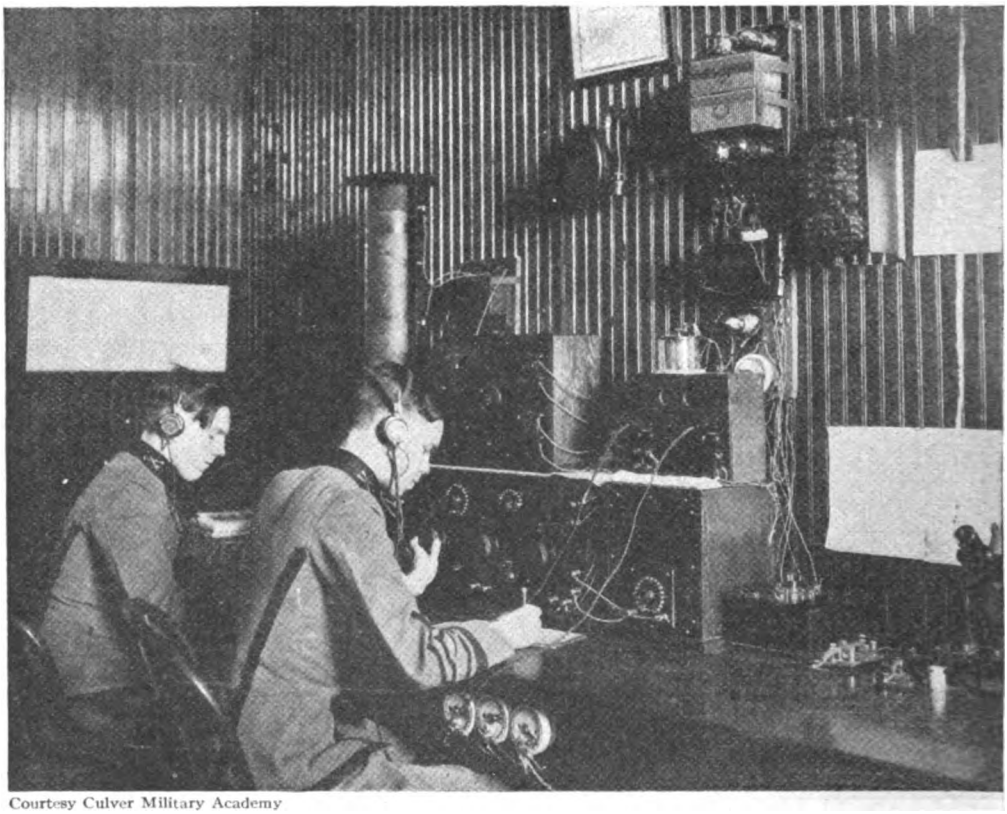

Courtesy Culver Military Academy

INSTRUCTION IN RADIO BECOMES PART OF THE SCHOOL COURSE

Work in both reception and transmitting has at least one extraordinary advantage; it teaches physical science in terms that the student can understand and in which he takes a practical interest. Courses in the theory and practice of radio are being incorporated in the curricula of both public and private schools.

sible to standardize our teaching and raise it to a higher level. Uniform examinations, which would be based upon the lessons covered and not merely upon a printed course of study, which allows a great latitude in interpretation, would then be possible. The questions could be read from the broadcasting station by the person in charge of that branch of the work, and the pupils could answer the questions after they were read. This type of uniform examinations would admit of no opportunity of knowing in advance, what the questions were to be. The other evils that go with the examination paper which has to be printed in advance and distributed with the greatest secrecy, would thus be eliminated.

All of these observations on the use of radio in the rural schools apply to the city school. Indeed, one of the greatest problems that confronts any school system is to obtain a constant supply of well-trained teachers. In this phase of educational administration radio can be of immeasurable assistance. Young teachers and teachers-in-training can learn a great deal by observing the teaching methods of their more experienced co-workers. It has always been difficult to arrange this type of observation. If a microphone were installed in the classroom and the recitation held under ordinary conditions, any number of teachers might listen in on this recitation. New methods in teaching could be presented to all of the teachers of

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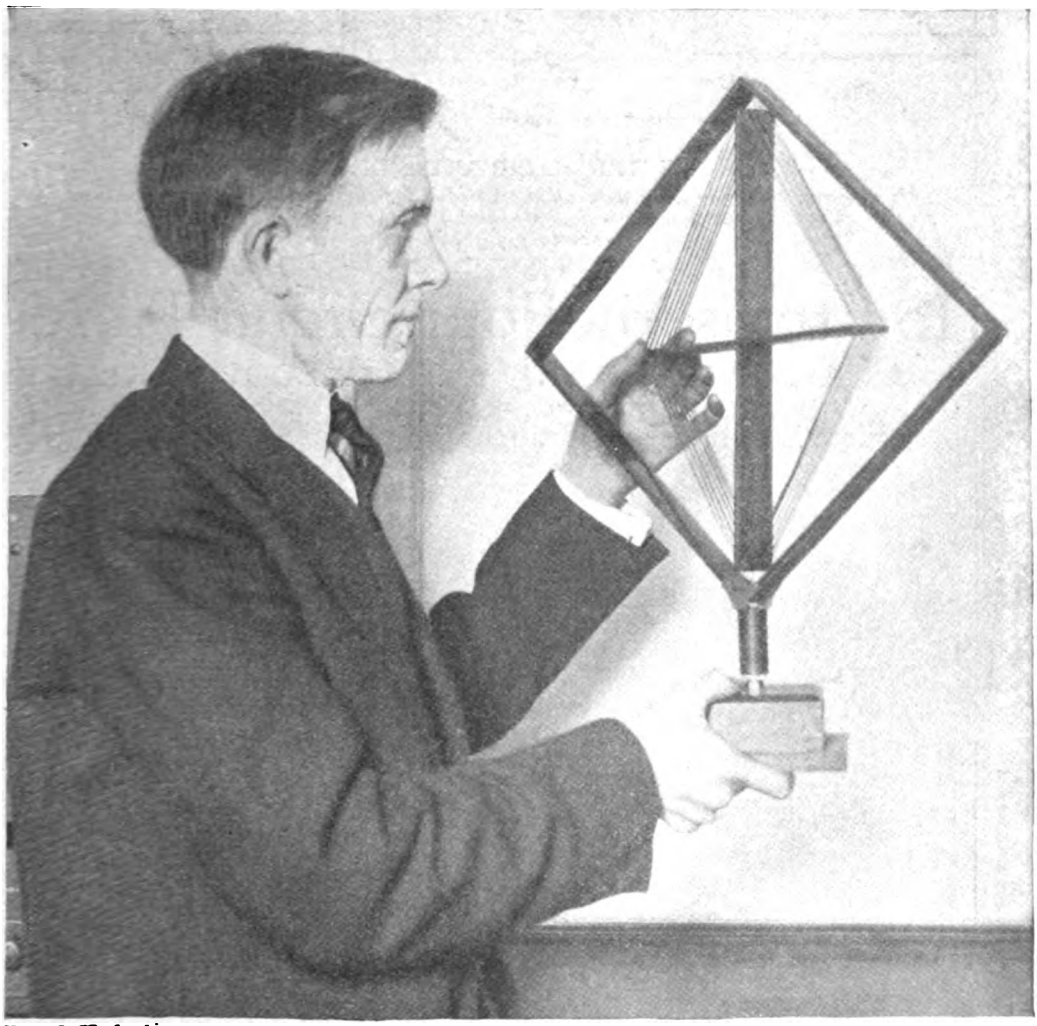
that subject, with the resulting benefit to the school as a whole.

In larger school systems, conferences could be called by radio; notices and instructions for the day could be announced; special announcements could be distributed to all concerned, while the subject matter is still vital. In many other ways, the efficiency of the educational system could be increased by the use of radio for broadcasting to classes.

And some day it will be.

A start has been made. There is a vast field still unexplored both for the school man and for the radio enthusiast. But the goal is worthy of the effort. Radio can be used in educational work in a useful and important way. It is up to the radio fan to point out those ways to the school man.



Kadel & Herbert

AN INDOOR ANTENNA THAT TUNES ITSELF

This small loop consists of two windings on a square frame. These two windings act as the coils of a variometer so that the wavelength of the antenna may be adjusted by simply revolving the inner winding. Signals from any particular direction may be picked up by turning the two windings together on a vertical axis. The loop was built by M. W. Obermiller, a New York amateur.

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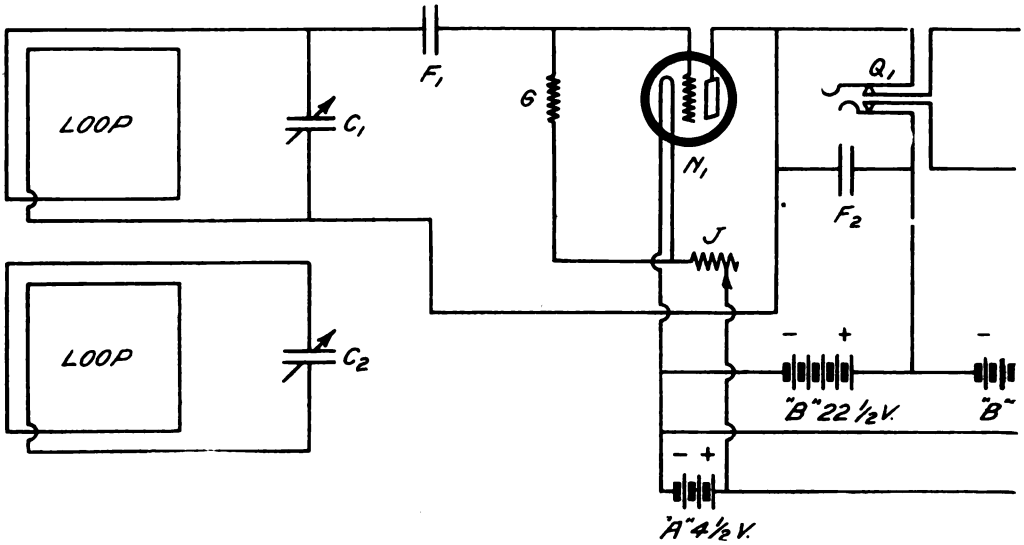

THE ELECTRICAL CIRCUIT CONNECTIONS

This diagram shows how to wire up the various instruments used in the hook-up, so that they will function properly. Be sure that they are followed out EXACTLY *in order to get good results.*

How to Use the Four-circuit Tuner

—AS A PORTABLE SET WITH A LOOP AERIAL

Here is a clever modification of the receiver described in the May issue that makes a neat little portable receiver and which has given the author satisfactory results on local reception.

By O. B. PARKER

DURING the past summer, more than ever before, the attention of radio fans has turned to portable receiving sets. Few of these portable sets are self-contained; most of them require some sort of an antenna and a ground. If a loop antenna is used, the set requires the use of radio-frequency transformers, and only a few of these give good amplification from 200 to 600 meters.

As I have had such good results with the Cockaday circuit both with and without antenna and ground, the thought occurred to me to build a portable set that utilized this circuit in a more or less modified form. This circuit embodies the following features:

1. loop reception without the use of radio-frequency transformers or reflex circuits;
2. uniform amplification over the entire wavelength range of from 200 to 600 meters;
3. freedom from static;
4. portability.

The following is a list of the more important parts that are required to build this set:

A—"Ultimate" cabinet;
B—two 7-inch by 10-inch bakelite or hard rubber panels;
C—two .0005 mfd. Cardwell variable condensers;
D—one first-stage Cardwell transformer (9:1);
E—one second-stage Cardwell transformer (4½:1);
F—two .00025 mfd. micon condensers;

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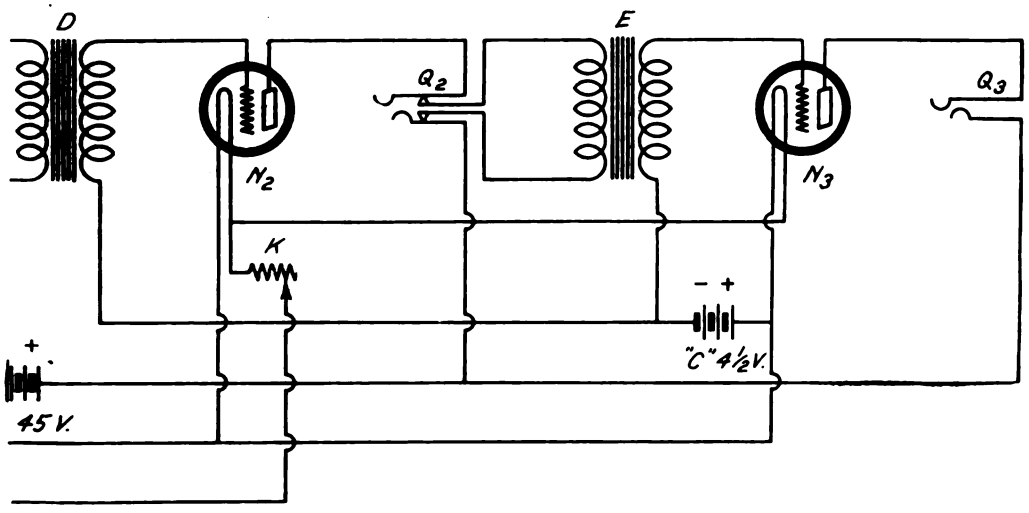

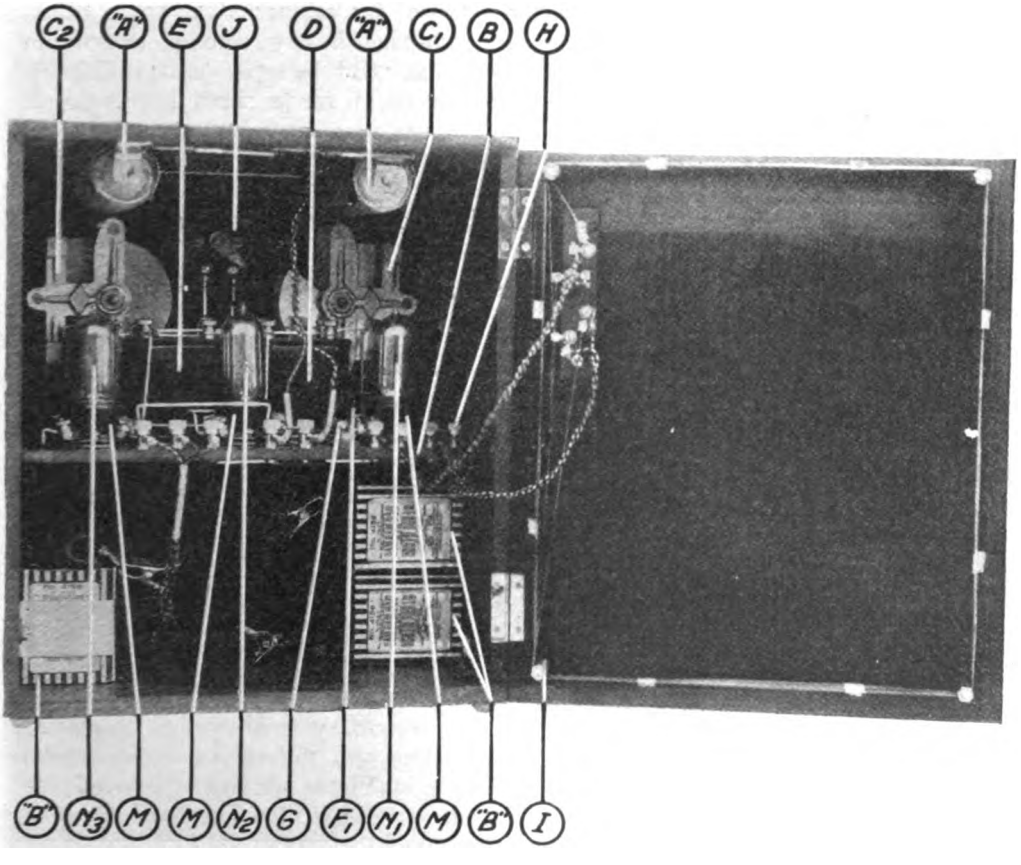

HOW THE SET IS CONSTRUCTED

This picture gives the manner in which the instruments are arranged in the cabinet. The various parts are designated by letters which correspond with those in the list of parts and the wiring diagram.

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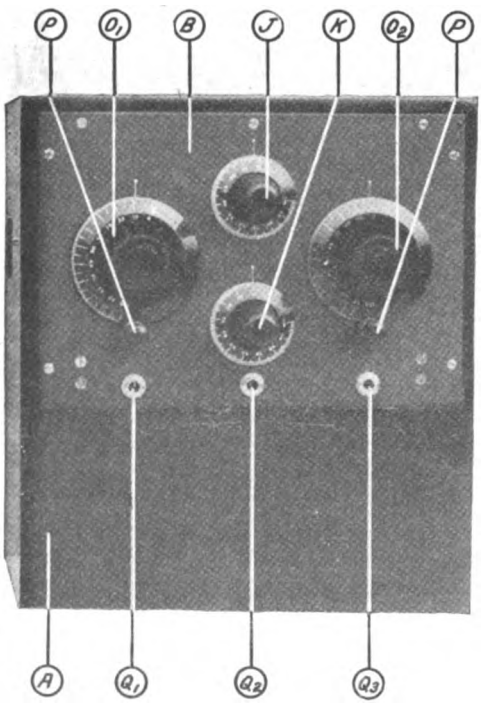
G—one 2-megohm leak and mounting;
H—nine binding posts;
I—four 1-inch lengths of hard rubber tubing, ¼-inch O.D.;
J—30-ohm Klosner rheostat;
K—20-ohm Klosner rheostat;
L—12 lengths of bus-wire;
M—three UV-199 sockets;
N—three UV-199 tubes;
O—two dials;
P—two dial verniers;
Q—three jacks; 2 single closed and 1 single open;
R—¼-pound of No. 22 D.S.C. or D.C.C. wire;
S—miscellaneous screws.

The layout of the panel depends on the individual taste of the constructor; the same observation applies to the arrangement of the amplifier.

The only details that need description are the loops. The door forms the frame for the loop. Four holes are drilled, one in each corner so that the square formed by them measures nine and one half inches on a side.



THE COMPLETE RECEIVER

The face of the panel has a neat symmetrical appearance that would not be out of place in any home. The two large dials are the tuning condensers and the two smaller ones are the rheostat controls.

Four 1½-inch 8/32 round-head screws are slipped in with the heads outside. Over these screws are placed the 1-inch lengths of hard-rubber tubing. A nut is put on each screw and tightened up. This forms the loop frame.

Securing the wire by means of a screw or small brad, wind on 13 turns of No. 18 D.S.C. copper wire and fasten the end. This is the main loop. Now start and wind the absorption loop right alongside of the first. This second loop has nine turns of wire. A small terminal block is fastened to the cover and flexible leads brought down to the binding posts on the sub-panel, as shown in the illustrations.

Small clips to hold the three-cell tubular flashlight batteries are mounted in the top of the cabinet. The space below the sub-panel is large enough to contain the small "B" batteries and still leave enough room for a small horn.

This set may be used on an antenna by simply fastening the regular Cockaday antenna loading coil on the inside of the cabinet door and placing it in series with a single turn of wire around the two loops. The antenna and ground binding posts are then put on the inside of the door. In this way the set may be used with antenna and ground for DX, while the loop is used for local reception.

It is very important that the condensers used in the set have practically no dielectric losses and a minimum capacity of less than .00002 mfd. The condenser should be of shielded construction with the rotor grounded.

The tuning of the four-circuit tuner, when used with a loop antenna, is done in the same manner as when the ordinary antenna circuit is in operation.

The secondary condenser is employed for picking out the various wavelengths and the stabilizer condenser is used for regenerative control. The loop must be turned with rotation about its vertical axis, to pick up stations in different directions, and this is done by swinging the door on its hinges.

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Capacity Calculations

—AND THEIR APPLICATION TO THE ANTENNA

Article No. 7

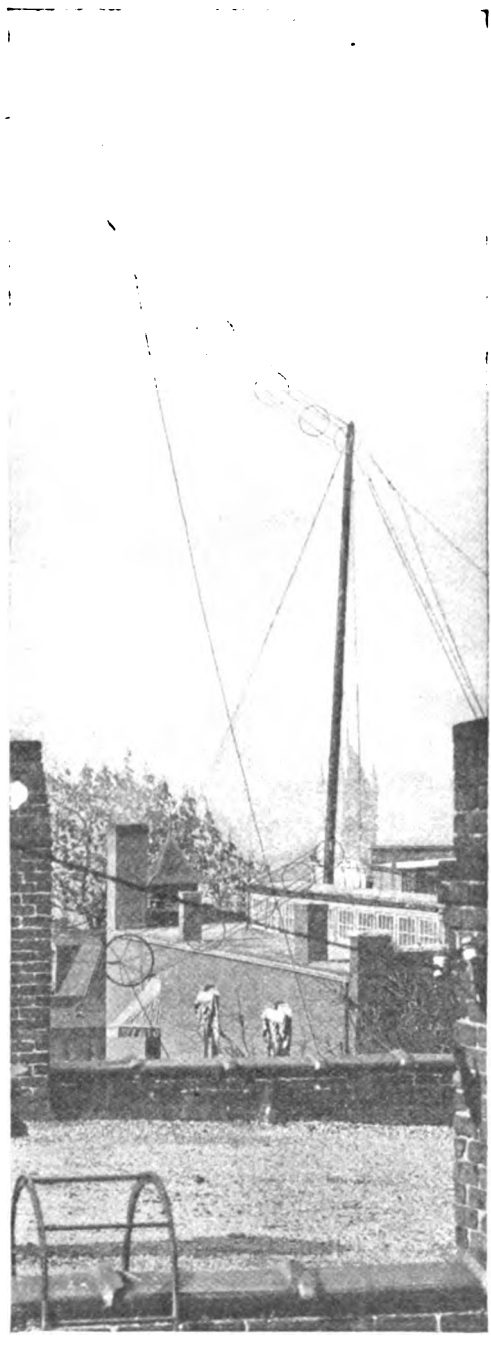
Many considerations enter into the calculations of antenna capacity; such, for example, as height above ground, proximity of nearby buildings and other objects, and the shape and type of the antenna itself. Those of our more experienced readers who have been following this author's series of helpful articles will profit by this newest contribution to the data he has already given them on the mathematical determination of antenna capacity.

By SIR OLIVER LODGE,
F.R.S., D.Sc., LL.D.

THE capacity of a body depends not only on itself but on its surroundings, especially on how near it is to other conductors. It also depends on the medium in which it is immersed. A condenser with glass or paraffin or mica or other insulating material between the plates has three or four times the capacity which it would have if the plates were separated only by air.

In estimating the capacity of an antenna, however, we have no medium to deal with except air, which is practically the same in this respect as absolute vacuum, or in other words, ether. For it is the ether of space and its properties on which electric capacity wholly depends. It is this which stores the energy in an elastic manner during charge, and yields it again during discharge.

The conventional unit of capacity is the farad, which is able to hold one coulomb, or c.g.s. unit of electric quantity, when charged to the potential of one volt. Such a quantity of electricity can be supplied by a current of one ampere flowing for ten seconds. This quantity is enormous, from the electrostatic point of view; and accordingly the cistern or capacity needed to hold it, at such low pressure as one volt, must be enormous too. Few of us have ever had to deal with one farad of capacity. We have



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to be satisfied with a microfarad, that is to say, the millionth part of a farad. But even that is too big for electrostatic purposes; so we take the thousandth or even the millionth of that, and speak of millimicrofarads or even micromicrofarads.

Interpreting these capacities as lengths*, we may say:

1 micromicrofarad= 9 centimeter
1 millimicrofarad = 9 meters
1 microfarad = 9 kilometers

while the length equivalent to a farad would reach far beyond the moon, twenty-four times the distance of the moon, or one-sixteenth of the journey to the sun.

The figure 9 which enters into these relations is rather a nuisance, but is inevitable. It comes in because the square of the velocity of light is involved; and as that velocity in c.g.s. measure involves a 3, its square naturally contains a 9. For ordinary purposes it is sufficiently near if we consider a micromicrofarad as a centimeter, instead of 10 percent less. It would be the capacity of a knob two centimeters, or rather less than an inch, in diameter.

On this principle we can estimate the capacity of an antenna by eye. Expressed as a length, the capacity of a vertical wire is just about one-twentieth of the height of the wire. Suppose the wire were 9 meters high, its capacity would be one-twentieth of 9 meters, that is, one-twentieth or .05 of a millimicrofarad. To get a single-wire vertical antenna of a whole millimicrofarad capacity, it would have to be 180 meters, or about 600 feet high.

But we must now consider this matter a little more strictly, and show how to calculate the capacity on orthodox principles.

To get the capacity of an isolated wire of length l and diameter d we have only to calculate

$$\frac{l}{2\log_e \frac{2l}{d}}$$

or what is the same thing

$$\frac{.217\,l}{\log_{10} \frac{2l}{d}}$$

It does not matter what units l and d are measured in, provided they are expressed in the *same* units, and the capacity will come out also in the same units; that is in units of length. To interpret that in millimicrofarads is easy enough in the light of what we have just been saying.

Thus, suppose that the length is 60 feet, and that the diameter is 1/10 inch; the above fraction is

$$C=\frac{.217\times 60}{\log_{10}\frac{120\times 12}{\frac{1}{10}}}=\frac{13.02}{\log_{10} 14400}=\frac{13.02}{4.16}=3.13 \text{ feet}$$

which is just about 1/20th of the length of the wire. This equals about 1 meter; so the capacity will be 1/9 millimicrofarad. Or take another example, using the upper of the two formulas above. Let the length of the vertical single antenna be 40 meters, and the diameter .8 millimeter.

The capacity

$$C=\frac{40 \text{ meters}}{2\log_e \frac{8000 \text{ centim}}{.08 \text{ centim}}}=\frac{40 \text{ meters}}{2\log_e 10^5}=\frac{40 \text{ meters}}{23}$$

which again would practically be one twentieth, or 5 percent, of the length, for a little extra allowance must always be made for the inevitable partial neighborhood of the earth. Interpreting this into conventional units of capacity we must divide by 9, and we find that it equals 40/207 or say 1/5 of a millimicrofarad.

If the wire is very thin, say .008 centimeter, its capacity would be rather less, but not much less; we should then theoretically have to divide the length by 27 instead of by 23. Or conversely, if the wire were thick, say 8 millimeters, which could be a thin rod, we should

*See appendix to Sir Oliver Lodge's article in Sept., 1923, issue POPULAR RADIO.

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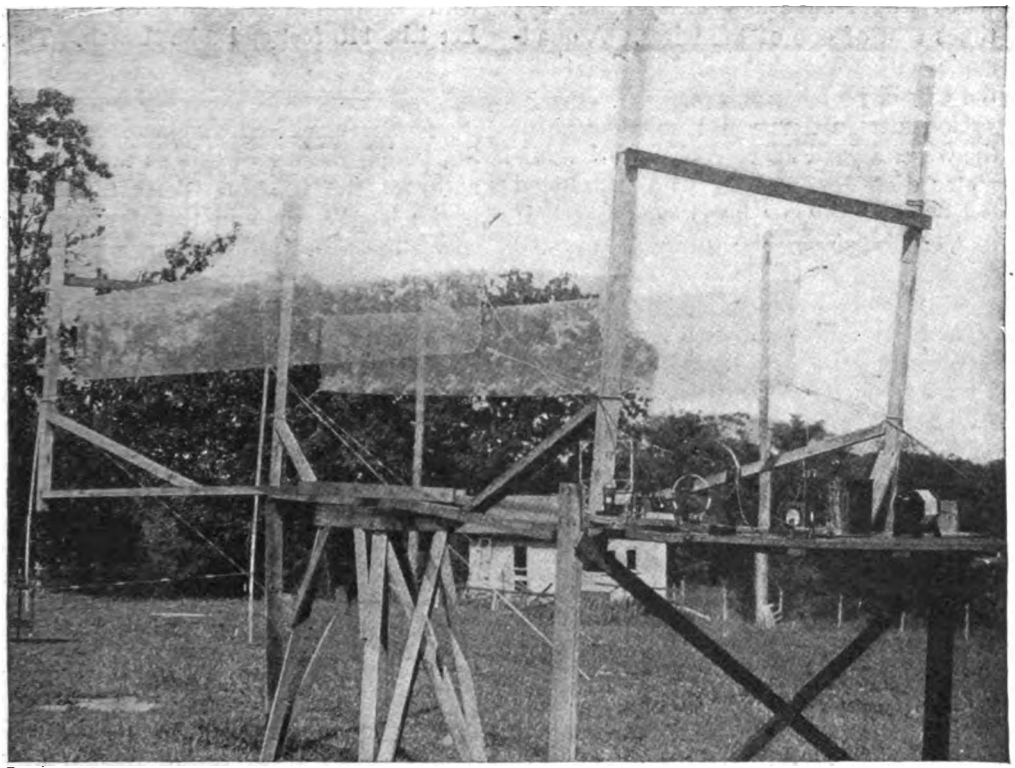

Bureau of Standards

ONE WAY OF TESTING THE CAPACITY FORM OF ANTENNA

Such an antenna, pictured above, consists of two rectangular pieces of copper-wire mesh suspended from a wooden frame by insulators. One end of the tuning inductance is connected to one plate and the other end of the coil is connected to the remaining plate.

have to divide the length by 18.4 to get the capacity. So in any practicable case we can estimate the capacity of a vertically arranged single wire as round about one twentieth of its length, with a 10 percent addition for the neighborhood of the earth.

The capacity of a horizontal wire is reckoned similarly, only then the denominator of the fraction contains four times the height above the ground instead of twice the length of the wire.

Suppose a horizontal wire at an elevation of 30 feet, of diameter 1/40th inch, and of any length 1, what would be its capacity. The formula is

$$C=\frac{1}{2\log_e\frac{4h}{d}} \quad \text{or} \quad \frac{1}{4.6\log_{10}\frac{4h}{d}}$$

All we need to reckon is the denominator.

Now

$$\frac{4h}{d}=\frac{120 \text{ feet}}{\frac{1}{40} \text{ inch}}=57600;$$

So

$$\log_e\frac{4h}{d}=\log_e 57600=10{\cdot}96$$

And the capacity is $\frac{l}{22}$ one twenty-second of its length. Every centimeter of this length is practically a micromicrofarad.

But the wire for a horizontal antenna would probably be somewhat thicker; if it was ¼ inch thick instead of 1/40 inch, the denominator would become 16 instead of 22. A double wire antenna with a space of 2 or 3 feet between the

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wires would have a capacity about 1¾ times that of one of the wires. A quadruple wire would have 2½ or 2¾ times the capacity of a single wire.

Consider a four-wire antenna with the wires a yard apart, each wire 1 millimeter diameter, and the whole arranged either vertically, or horizontally at half its length above the ground, say 10 meters high and 20 meters long. Each wire if alone would be likely to have a capacity roughly estimated at its length divided by $4.6 \times \log_{10} 40{,}000$, which is 21. So the capacity of the whole would be about 2½ times the length of the antenna divided by 21, that is, 2.4 meters, or roughly about an eighth or ninth of the length of the wire grouping. If the wires were further separated, say by 2 yards, the combined capacity would be rather greater, and might be three times that of a single wire.

Examples

I might take a few examples to illustrate that the capacity of a wire antenna does not depend very much upon the thickness of the wire. Consider a vertical or isolated wire 20 meters long. If its thickness is .04 centim. or 2/5 millim., its capacity reckoned by the formula will be:

$$C = \frac{1000}{\log \frac{2000}{.02}} = \frac{1000}{\log 10^5} = \frac{1000}{11.513} = 86.85$$

or say 90 centim. which is the same as 100 micromicrofarads.

If the thickness is 1/10 of the above, say 1/25 millim., the denominator of the above fraction will be 10^6 instead of 10^5, and the capacity comes out 72 centimeters, instead of 90.

If, on the other hand, the wire is 4 millimeters thick the denominator is 10^4, and the capacity comes out 110 centimeters.

I will take one more example, with the length expressed in feet and inches, to show that it does not matter what units are employed, so long as we deal with them in common-sense fashion. Let l be 110 feet and d be .1 inch. Then

$$\frac{2\,l}{d} \text{ will be } \frac{220 \times 12}{.1} = 26{,}400$$

So, taking the log of this as the denominator of the fraction whose numerator is the length, we find that the capacity comes out about 5½ feet, or, with allowance for earth neighborhood, 6 feet. Every foot being 33 micromicrofarads. We can think of this as the equivalent of an isolated sphere 12 feet in diameter or as 180 micromicrofarads. Capacity can always be expressed in linear measure, but the ethereal constant K has always to be understood if any rational meaning is to be attached to the length specification of capacity. But as K is unknown, it is conventionally taken as unity, when electrical quantities are specified on the electrostatic system. It is convenient, then, to express capacities as lengths, and inductances also as lengths, for then the square root of the product of these two lengths, that is their geometric mean, gives a length proportional to the wavelength, and only requires multiplying by 2π in order to give the wavelength itself in the same length units, whatever they are.

But it will always be found that the capacity is expressed by a small length, while the inductance is expressed by a big one. One may be in meters, while the other may be in kilometers. But whether they are expressed in meters, or centimeters, or feet, or yards, matters nothing, so long as one always writes down the unit of measurement after the figures. Units of measurement ought not to appear in algebraical equations or expressions, but should always be written after arithmetical figures, except when those represent a pure number. This would avoid a great deal of confusion and trouble, and is a matter not sufficiently attended to. Hence the emphasis here laid upon what ought to be an elementary and fundamental consideration. Unfortunately mathematicians

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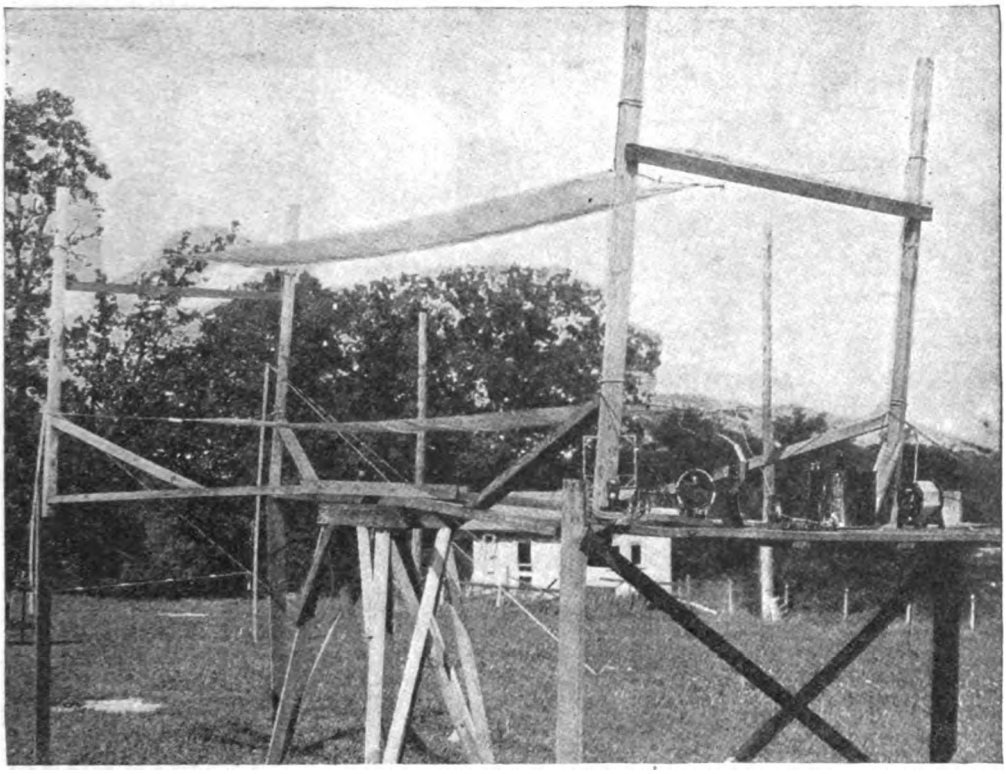

Bureau of Standards

ANOTHER SET-UP FOR TESTING OUT THE CAPACITY FORM OF ANTENNA

In this case the two mesh "plates" are suspended horizontally. The same general law for capacity determination holds true for this miniature antenna as for your own antenna which is ten or fifteen times the size.

who are not physicists do not always agree with this, and, like the late Mr. Todhunter, think that an algebraic expression is incomplete unless the units are stated. Physicists know that the units *only* ought to be stated in connection with arithmetical specifications. The velocity v, for instance, is complete in itself, and is the same thing whatever units are used; whereas a velocity 36 means nothing, unless feet-per-second, or miles-per-hour, or centimeters-per-second, are explicitely added. To say that the height of a post is 50, means nothing. But to take the height of a post as h is quite correct and complete. The post is the same height whether it be measured in feet or centimeters or anything else. So also the velocity of light is the same velocity, however expressed, and can be written completely as either v or c, according to taste.

Units should be expressed after figures, but not after algebraic symbols; except when these are used in some shorthand technical formula, which is essentially an arithmetical one and must be so treated.

When writing down a capacity always say what units are intended, otherwise the specification may be misinterpreted many hundred-fold. A microfrad is equivalent to a length of 9 kilometres.

This might be learned by heart.

IT *is only a matter of time when transatlantic radio telephony will be as common as line telephony is today. How science is preparing the way for this new marvel will be told in a coming issue of* POPULAR RADIO.

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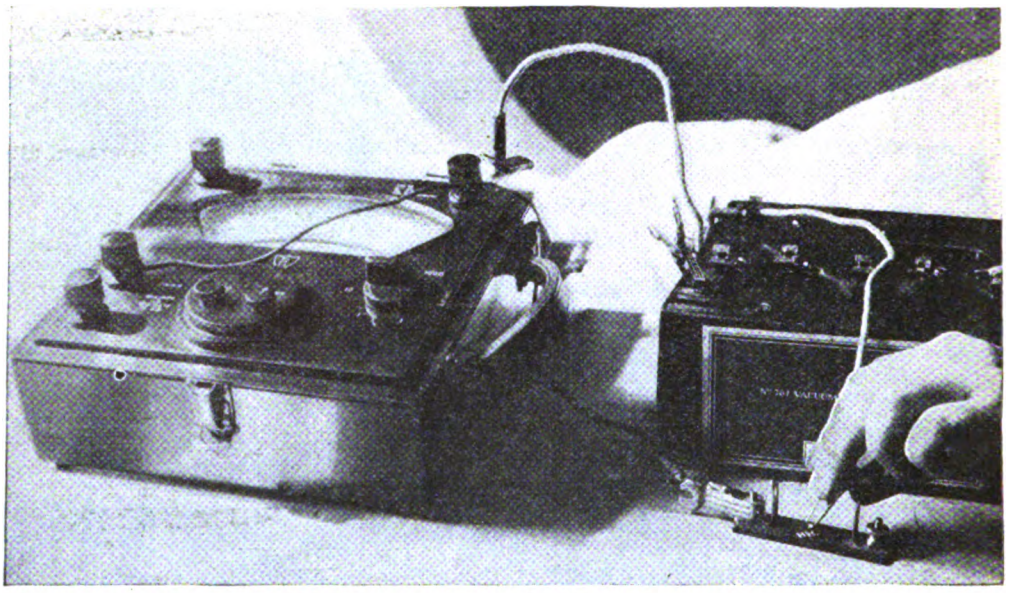

AN ELEMENTARY TEST OF INSULATION

With a regular "B" battery and an extremely sensitive microammeter connected in series with a piece of insulating material, it is sometimes possible to get a current of 15 microamperes to flow through the insulation. This test is a crude test, however, and would only serve to show up a very poor piece of insulating material.

Practical Hints About Insulation

—THAT EVERY RADIO FAN SHOULD KNOW

By RAYMOND FRANCIS YATES, R.E.

ALTHOUGH Professor Einstein did not specifically say so, insulation is a relative term. A substance that will effectively insulate at one voltage will pass current under another as freely as water passes through a sieve. Indeed, there is *nothing* that will not pass a certain quantity of electricity. Therefore, we insulate to *minimize* the leakage of currents.

Electric leakage is an insidious thing from the viewpoint of the radio fan. When a water pipe, boat or air tank leaks it is a simple matter to find the outlet and to apply the needed remedy, but in a radio set we can have a leak as big as all outdoors and still we cannot see the invisible fluid that manages to escape. If there is anything that will quickly reduce the efficiency of a radio set, it is poor insulation. This is doubly true about transmitters, and even in receivers it is an important factor.

The degree of insulation necessary depends upon the voltage used. A water pipe that carries ten gallons of water per minute at a pressure of 60 pounds to the square inch would probably burst if the pressure in pounds to the square inch were suddenly multiplied by five. The same might hold true of a wire carrying electric current; if the voltage were suddenly multiplied by five or even by two, the insulation would become ineffective and we would experience

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heavy leakage. Although insulation cannot burst, it can break down electrically and burn up when the voltage reaches the rupture point where it can puncture things in its path that offer resistance.

There are two things that are most important in considering the subject of insulation: One is *voltage*, as we have already seen. The higher the voltage the greater the resistance of the insulation must be, to effectively keep it in its path of virtue, so to speak. The other factor would probably be little suspected by the average experimenter. It is *frequency*.

The way in which frequency affects an insulating substance may be a bit obscure, but nevertheless this fact is as true as the law of gravity. Some notion of the importance of frequency and its effect upon dielectric strength (insulating strength) may be gained from the fact that an insulator that will stand up under an application of 100,000 volts at a frequency of 60 cycles per second may break down and become totally ineffective under a voltage of 20,000 at 150,000 cycles per second. From this we learn that radio-frequency currents are much more difficult to handle and insulate. They are the wilder and more unruly members of the electric-current family.

It is usual to measure resistance of insulating materials in ohms just as the degree of resistivity offered by a copper wire is measured in ohms (or fractions of an ohm). In measuring resistance of real insulators we have such "gobs and gobs" of ohms that we use a more convenient term, the megohm (1,000,000 ohms). That this term is more convenient will be appreciated when it is understood that a unit cube of a good insulating material might have a resistance of 100,000,000,000,000,000 ohms.

The dielectric strength of any substance (and by this we mean its ability to resist a voltage that would tend to break it down) can be likened to the mechanical strength of the metal in a high-pressure tank. Any dielectric or insulating substance has a critical voltage point at which it will rupture or break down and allow current to pass through it freely. If it is a good insulator the amount of voltage that must be applied to do this is necessarily high, ranging from 1,000 to 500,000 volts for the different thicknesses of insulation.

Dielectric strength is measured in terms of the number of volts required to puncture any definite thickness of the material. It is a sort of indefinite quantity, since it is difficult to measure with any degree of accuracy. In the accompanying illustration we see a small high-potential transformer of 7,000 volts potential, set up to puncture a small thickness of insulation of the much-used "mud" variety, which is usually a combination of lampblack and shellac. The voltage at which puncturing takes place, depends upon the *frequency* of the current, the *time* during which the voltage is applied and the *size* and *shape* of the electrodes and their *distance* apart.

For instance, the use of needle points will often cause a breakdown at voltages where flat surfaces will not. This, of course, can be understood since what we might call the voltage gradient in the insulator is larger in the case of the needle points and a smaller area of the insulator is called upon to withstand the entire strain. If the same load were distributed over a larger area the insulator might successfully withhold it.

The insulating materials that we use in our radio sets should be of the best variety. The "mud" referred to should be used only where it is not called upon to resist the passage of radio-frequency currents, no matter what their voltage value may be. The writer has made a number of tests on the insulating strength of some of the lower grades of this substance and he finds that at radio frequencies they pass a considerable amount of current even when the voltage

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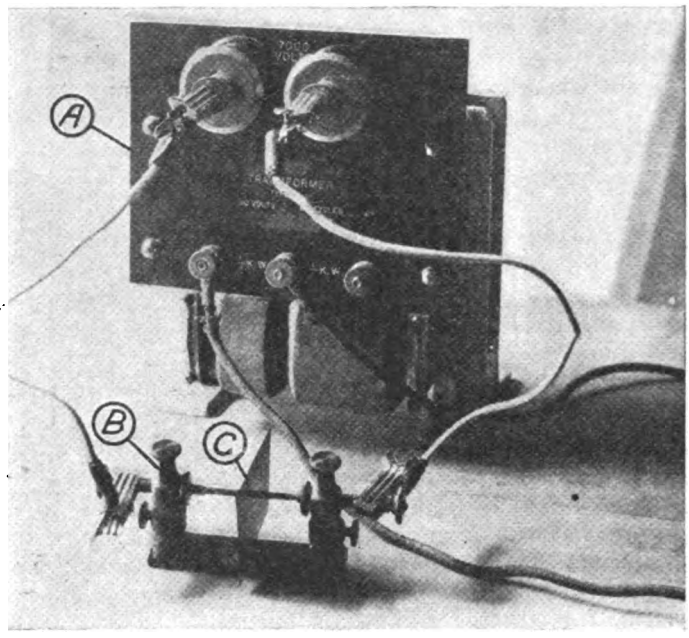

A TEST OF THE DIELECTRIC STRENGTH OF AN INSULATING SHEET

A high-potential transformer A is connected across the terminals of a spark gap B. The sheet of insulation of known thickness is then fastened between the electrodes of the spark gap and then the voltage of the transformer is raised until the dielectric strength of the sheet is overcome and a spark passes through the insulation. The voltage at which this electric breakdown occurs is the dielectric strength of the material, and it is measured in volts per mil.

is seemingly insignificant. Some of this material makes beautiful-looking grid leaks and it is only necessary to mount the binding posts *in* it at a definite distance apart to obtain any number of megohms or fractions of a megohm as a grid leak! Even with a direct voltage, this material shows the passage of dangerous amounts of current. A simple experiment with a microammeter, similar to that shown in the photograph gives indisputable proof of this statement. If a small piece of the stuff is connected up in series with a 100-volt "B" battery, appreciable quantities of current will be allowed to pass, even when the electrode separation is comparatively large! With a separation of ½ inch the writer has had an ammeter reading as high as 15 microamperes. According to Ohm's Law, $R=\frac{E}{I}$. If we have a current of .00000025 amperes and a voltage of 100, it is evident that the insulation is only 4 megohms which is disgustingly low for anything that is dignified by the name of insulation. This material is probably all right to use for knobs, dials and the like, but its performance as a restrainer of electric pressure is not sufficiently noteworthy to warrant its use in radio equipment.

Any of the synthetic-resinous products are well suited to radio use whether in transmitters or receivers. They offer a fairly substantial resistance to moisture, their dielectric strength is high and their mechanical strength is enormous. The writer can say little in favor of vulcanized fibre as far as its use for radio insulation is concerned. Its use for panels is to be discouraged, since it has a terrific appetite for water and sucks in atmospheric moisture with sponge-like efficiency. Fibre has a dielectric strength of 330 volts per mil,

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or 13,000 volts per millimeter with a thickness of 1/32 of an inch. This, of course, is in the perfectly dry state (which is unusual and which can be maintained only in the laboratory under experimental conditions). Compared with this, the resinous materials show a dielectric strength of 1,000 volts per mil or 39,400 volts per millimeter in a thickness of 1/32 of an inch. A good piece of this material has a volume resistivity of about 1,000,000 megohms (10^{12} ohms) per centimeter cube. The surface resistivity may be anywhere from 100 megohms to 10,000,000 megohms. These figures show us that any of these products can be used with perfect safety as panels and for other insulating purposes in a radio set. There are numerous grades of this type of material. One is formed by allowing sheets of paper, white duck, or cloth to soak in raw resinous liquid varnish. The sheets are then placed one on top of the other in a powerful steam-heated hydraulic press. The press comes down, giving the sheets a tremendous squeeze and heating them at the same time. When the sheets come forth from the press they are in a much changed condition. What was once 50 or 75 sheets is now a single flat block of exceptionally hard material that will resound healthily when it is struck a sharp blow with a hammer. The sheets are welded together, forming a homogeneous material.

Other forms of insulating materials are molded. For instance, molded, synthetic-resinous or rubber materials are placed in the mold and subjected to heat and pressure at the same instant. The material fluxes and becomes almost semi-fluid, filling every interstice of the die. There is both a chemical and physical change. The chemical change is irreversible and permanent.

Most of the "spaghetti" that we buy is composed of cloth tubing impregnated with either oxidized linseed oil or raw bakelite varnish. This material should be freely used where bus or other wire comes in contact with the wooden parts of the cabinet. In no case should the connecting wires be allowed to make contact with the wood without being heavily insulated. Wood is an exceptionally poor insulator and is usually filled with atmospheric moisture.

The writer hopes that those who have read this article will give more thought to the insulation of their radio outfits henceforth. Insulation is a mighty important thing, and since we cannot see the leakage that is taking place there is only one thing left to do. That is to insulate our outfits, in the very best manner that we know how, using materials that have proven their real worth in the workaday world.

Another Measurement Chart—

for use in designing a transformer

In the next issue of POPULAR RADIO will be published the 6th of the series of practical time and labor-saving charts designed by Raoul J. Hoffman. The previous articles contain charts *For Determining the Constants of Radio Circuits and Calculating Capacities of Condensers in Series,* in February, 1923; *For Determining the Dimensions of Your Coil,* in March, 1923; *For Determining the Capacity of a Condenser,* in May, 1923; *For Determining the Capacity of Your Antenna,* in July, 1923, and *For Determining the Constants of a Loop Antenna* in August, 1923.

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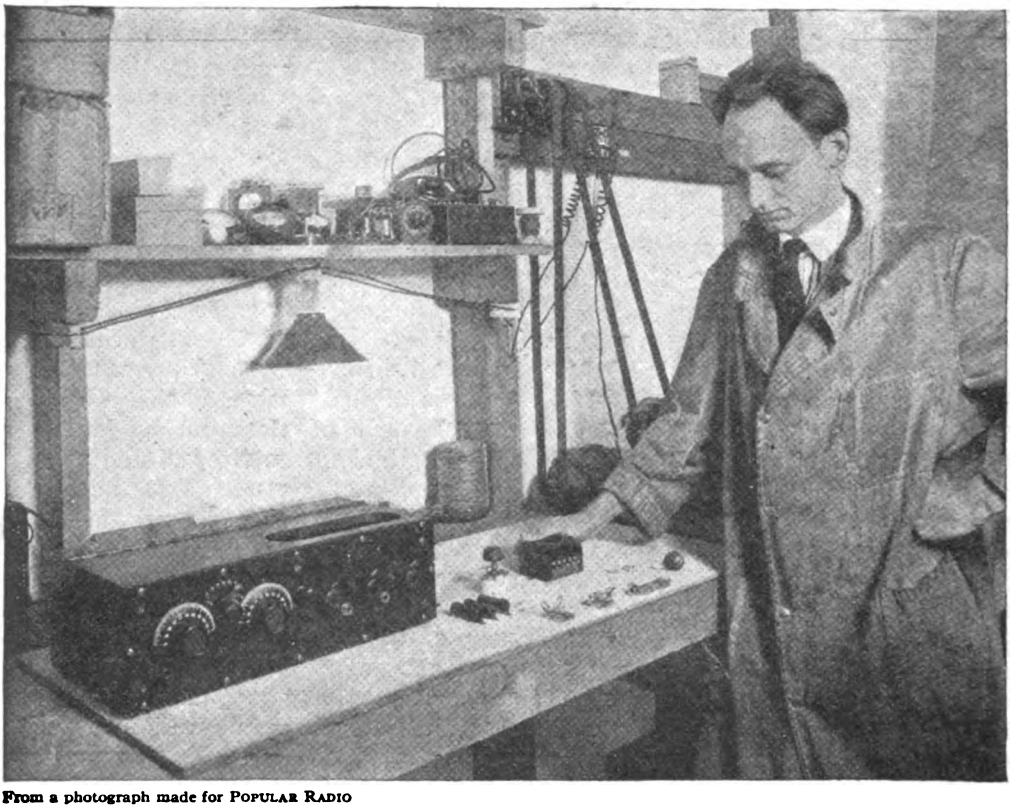

From a photograph made for POPULAR RADIO

Preparing to revise the old four-circuit tuner and to add to it the push-and-pull power amplifier. This does not incur any large expense and greatly raises the efficiency of that already efficient tuner.

HOW TO IMPROVE THE THREE-TUBE

FOUR-CIRCUIT TUNER

For the benefit of the many experimenters and radio fans who have built the Four-circuit Tuner described in the May issue of this magazine and who may not want to tear it down to build the new and improved tuner described in the January issue, we are giving in this article the necessary instructions for adding to the old set in order to bring its efficiency up to that obtained in the improved set.

COST OF PARTS: *About $30.00*

RECEIVING RANGE: *Up to 3,400 miles*

THE ITEMS YOU WILL NEED—

One pair of Como push-and-pull amplifying transformers;
one filament rheostat, 20 ohms;
one vacuum-tube socket;
one switch lever;
four switch points;
two switch stops;
one Bradley-leak;
one Amplex grid-denser;
two single-circuit jacks;
two telephone plugs;
six binding posts;
one panel, 5 inches by 8 inches;
one cabinet to match set;
one Amertran amplifying transformer;
three Lavite resistances, 50,000 ohms each.

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IN order to improve the old set and make it as efficient as the five-tube set described in the January issue it would be advisable to use the Amertran transformer for the first stage of amplification and shunt the primary winding with the small variable condenser (the grid-denser). The fixed grid leak should also be replaced, and the Bradley-leak inserted instead. This will help greatly in increasing the sensitivity and will allow of nicer adjustment of the circuit.

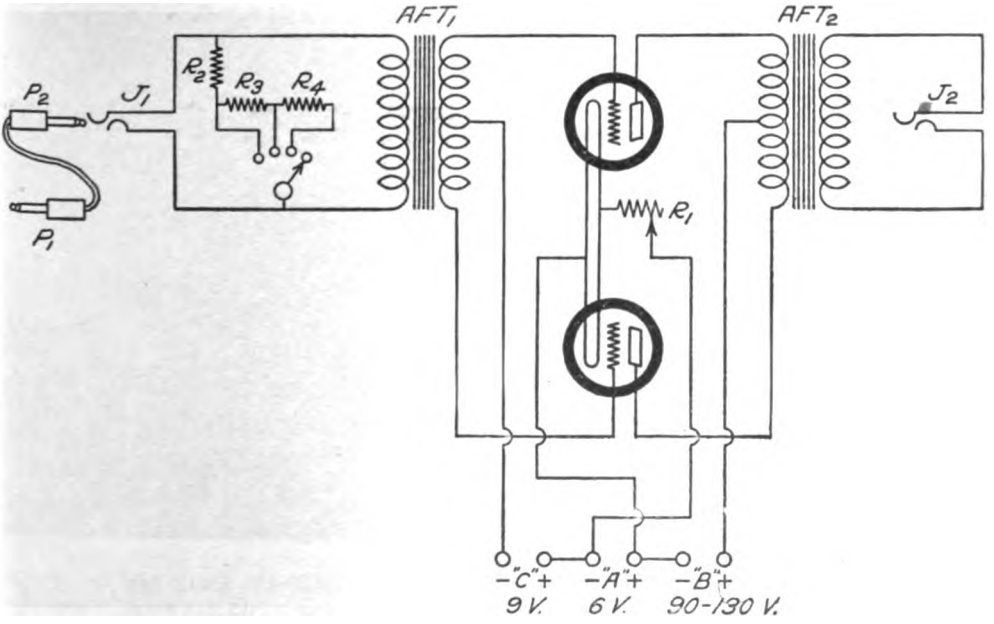
This includes all of the improvements necessary on the set itself. The rest of the work includes laying out one stage of power amplification on the new panel so that it may be (when placed in the new cabinet) set next to the old three-tube set on the right side. This will give the same volume and characteristics as the new five-tube set.

The new panel (which is the same height as the one in the old set) should be laid out with a neat arrangement of the rheostat and the two jacks. The two jacks should preferably be placed on the same horizontal line as in the receiver, and one should be at the left of the panel and one at the right. One of these is used, in connection with the two telephone plugs and two pieces of stranded wire, for connecting the output of the receiver with the input of the power amplifier. Place one plug in the last jack of the receiver and the other plug in the first jack of the amplifier.

The switch lever and switch points should be mounted on the amplifier panel and connected to the resistances. These are used for controlling the volume output of the amplifier.

The wiring diagram for the complete amplifier is shown in Figure 1. The same "A" battery should be used as for the receiver but a separate "B" battery would be preferable for the amplifier. Two UV-201-a tubes are recommended. Be sure to use the correct value of "C" battery as indicated on the diagram.

When you want to use the set alone



HOW TO WIRE THE AMPLIFIER PANEL

FIGURE 1: *This diagram gives the proper connections for all the instruments and parts that go into the amplifier cabinet which may be placed at the right-hand side of the set. The power amplifier is plugged into the second stage of amplification by means of the Plug P1.*

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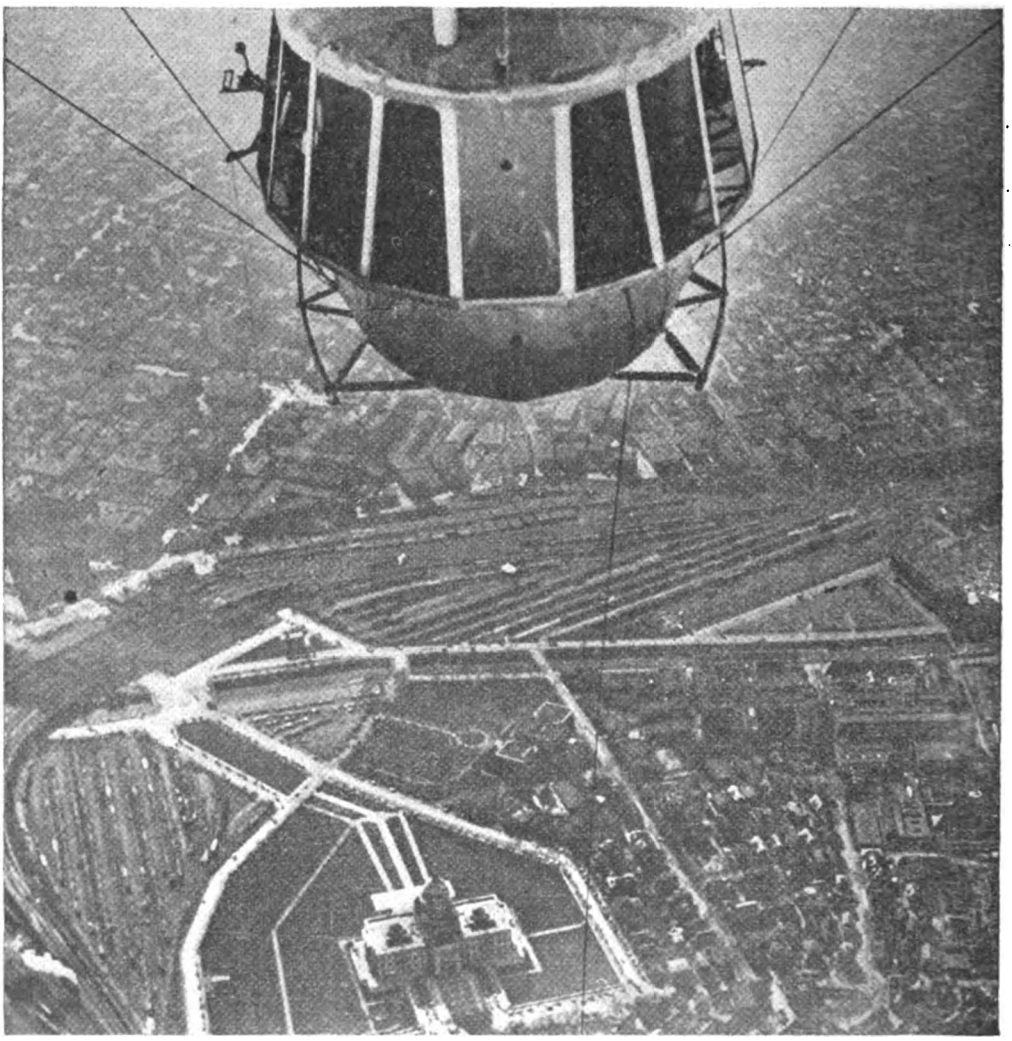
without the power amplification, merely take out the interconnecting plug and insert the telephone plug on your telephones or loudspeaker. If you want to listen *with* the power amplification insert the interconnecting plug into the proper jack on the set and the proper jack on the amplifier and insert the loudspeaker plug into the last jack of the amplifier tubes and listen in.

The addition has a good appearance and it is worth while for those who have the three-tube set and do not wish to tear it down to make the five-tube set.



Kadel & Herbert

A RADIO STATION FOUR THOUSAND FEET IN THE AIR

This picture shows the control car of the great Navy airship SHENANDOAH, *taken recently as she was flying over Providence, Rhode Island. The wire hanging downward from the side of the car is the radio antenna, which can be rolled in when the car approaches the earth. On her recent trips as far north as Boston and as far west as St. Louis, the commander of the* SHENANDOAH *has kept in continual touch with his base by radio. The same procedure will be followed next year when the* SHENANDOAH *attempts to fly to the North Pole and back.*

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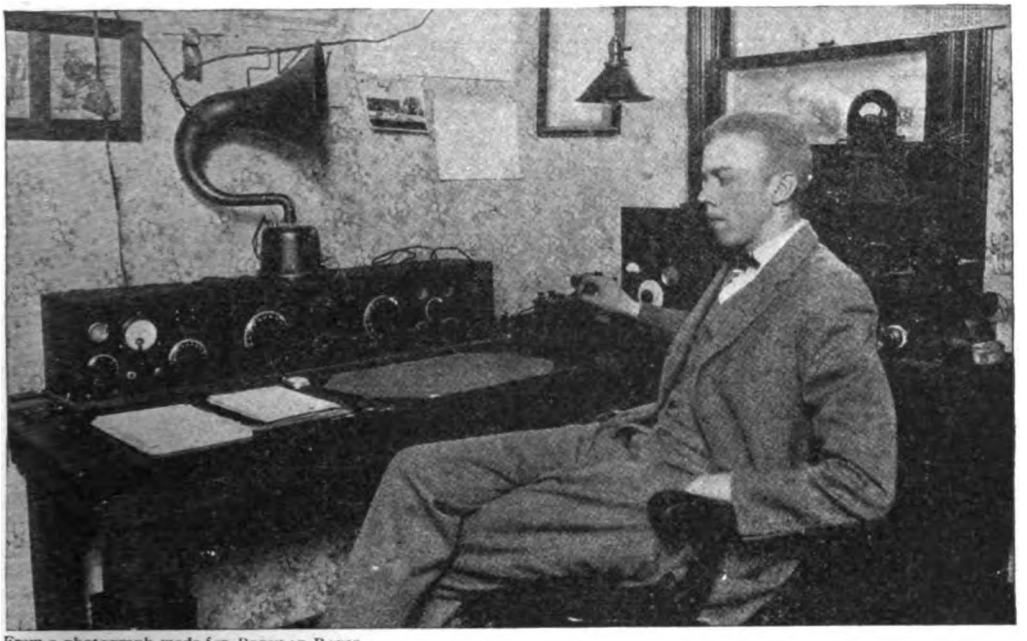

From a photograph made for POPULAR RADIO

The author is here shown seated at his receiving table upon which are arranged the three-tube set (at the right) and the oscillator (at the left).

HOW TO BUILD A

THREE-TUBE REFLEX RECEIVER

PART I

By WALTER A. REMY

COST OF PARTS: *About $70.00*

RECEIVING RANGE: *Up to 3,000 Miles*

HERE ARE THE ITEMS YOU WILL NEED—

B—primary coupler coil;
C—secondary coupler coil;
D—grid loading coil;
B1—primary switch arm;
D1—grid coil switch arm;
E—variable condenser, .00025 mfd.;
F1, F2, F3—mica fixed condensers, .001 mfd.;
G—grid leak and holder, 2 megohms;
H—mica grid condenser, .0005 mfd.;
I—mica phone condenser, .005 mfd.;
J—telephone jack, single circuit;
K1, K2—radio-frequency transformers;
K3, K4—audio-frequency transformers;
L—potentiometer, 200 ohms;
M—mica fixed condenser, .002 mfd.;
N1, N2, N3—vacuum-tube sockets;
O1, O2, O3—filament rheostats, 6 ohms;
P—composition panel, 7 by 24 inches;
Q—composition panel, 3 by 9 inches;
R—composition panel, 2½ by 9 inches;
S—composition panel, 1 by 9 inches;
7-inch by 24-inch cabinet;
12 binding posts;
4 switch stops;
16 switch points;
3 vacuum-tube bezels;
2 vernier dial controls;
2 four-inch dials;
4 two-inch rheostat dials;
½-inch brass strip for shelf support.

ONE of the most practical receivers that can be had is the so-called reflex receiver.

The main advantage of a reflex receiver is that it permits high amplification with a minimum number of vacuum tubes. In this circuit each tube acts as both a radio-frequency and an audio-

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frequency amplifier, thus making for an economical arrangement.

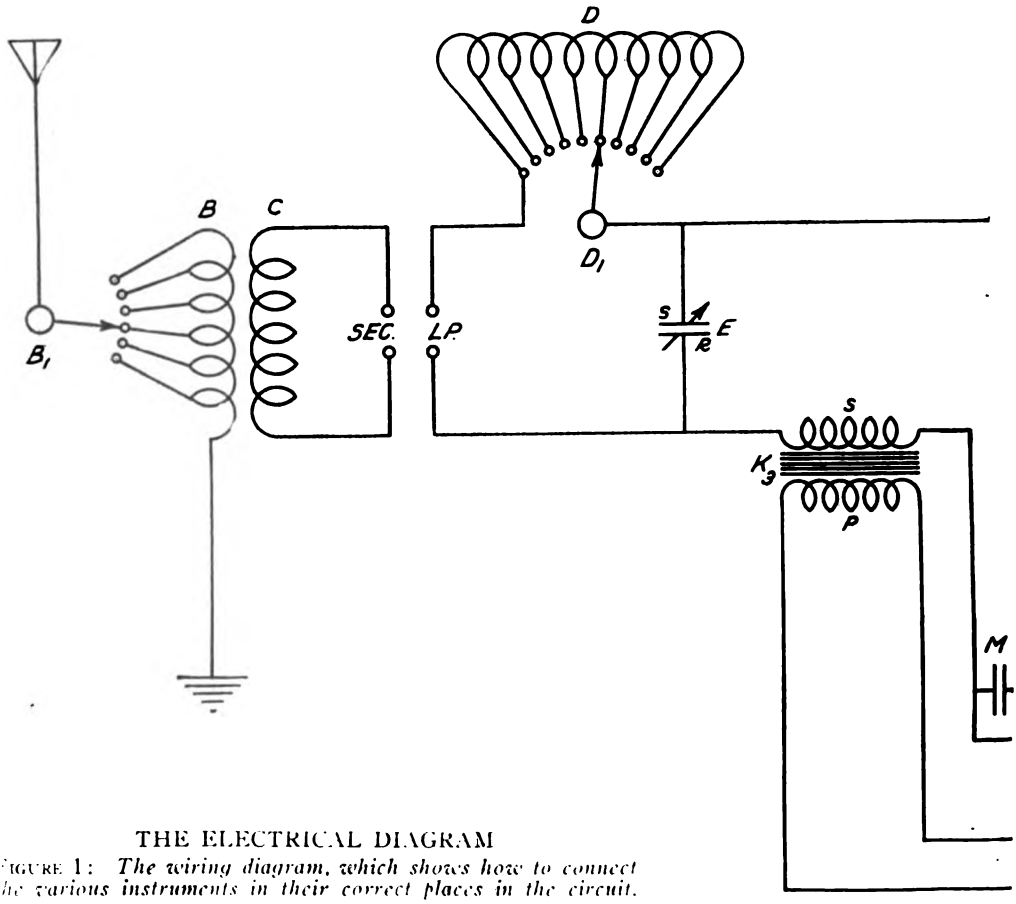
The circuit is by no means new. It was developed by the French almost a decade ago. Vacuum tubes and coupling transformers for amplification were unreliable in those days and were known only to the engineers. It was the recent war that put this circuit on a practical basis.

A general idea of the action of the circuit will be helpful.

There are two kinds of amplification; radio-frequency, in which the signal received is amplified before it is rectified (or detected), and audio-frequency, in which the signal is amplified after it is rectified.

In an audio-frequency amplifier the output of the amplifier is approximately proportional to the square of the voltage impressed on the grid of the tube. It is easily seen that strong local signals would, therefore, drown out weaker distant signals. For instance, consider that in the detector circuit of a conventional two-stage, audio-frequency amplifier receiver, a local signal is four times as loud as a distant signal. Then in the first amplifier stage it may be sixteen times as loud and in the second stage it may be two hundred times as loud. In this way the tuning of an audio-amplifier set is "broadened."

Exactly the reverse is true in radio-frequency amplification. The louder the signal the more the tubes will tend to "paralyze" and, therefore, fail to amplify. A weak signal is greatly amplified, however; that is why local stations



THE ELECTRICAL DIAGRAM

FIGURE 1: *The wiring diagram, which shows how to connect the various instruments in their correct places in the circuit.*

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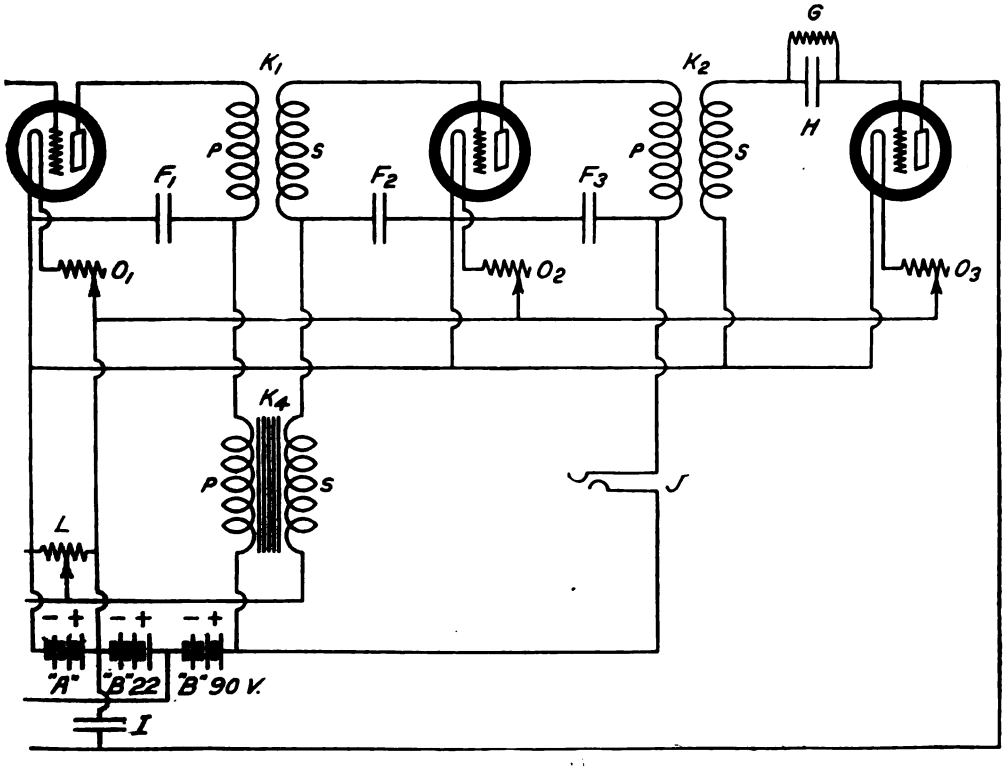
do not seem to be much louder on a radio-frequency set than on an ordinary outfit, while distant stations are heard almost as loud as the local stations. Hence it is clear that much sharper tuning is attained with a set that uses radio-frequency amplifiers.

The one drawback to a radio-frequency amplifier lies in the fact that the signal strength is not usually great enough to operate a loudspeaker. To overcome this objection a stage or two of audio-frequency amplification is added to the detector circuit. This necessitates the use of four or five tubes, and this involves an expense that places such a set out of reach of the average enthusiast.

The reflex circuit solves this problem.

By referring to the schematic diagram in Figure 1 it may be seen that the radio-frequency transformers are connected to the negative filament through condensers. These condensers bypass the radio-frequency currents in each stage. The signals are then rectified and are fed into the primary of an audio-frequency transformer. The secondary of the transformer transfers the audio-frequency current (which has been rectified and converted into an audio-frequency current) back to the first tube. Here *it goes through the first amplifying tube a second time*. This tube is also passing the radio-frequency currents simultaneously, but no trouble occurs because an audio-frequency current can be impressed upon a radio-frequency current with little distortion effects. In the plate of the first tube the audio-frequency current cannot pass to the filament through the condenser, as the condenser will only pass the radio-frequency currents.

In this way the audio-frequency current reaches the primary of the second audio-frequency transformer where the same action takes place and the signal is finally heard in the phones, which are



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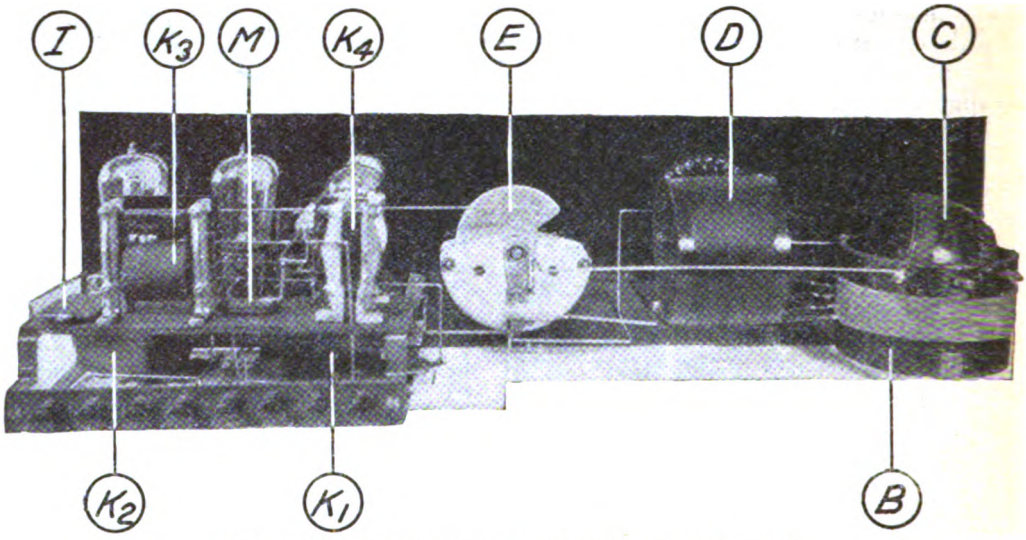

INTERIOR VIEW OF THE SET FROM THE REAR

FIGURE 2: *This photograph shows the general arrangement of the instruments which are mounted on the main panel, on the shelf, and beneath the shelf. The binding posts are fastened to a thin composition strip at the back of the shelf.*

in the plate circuit of the second tube. Thus we have a three-tube receiver with two stages of radio-frequency amplification, detector and two stages of audio-frequency amplification.

So much for the operation of the circuit; now for the practical construction of a reflex receiver.

The receiver described in this article was the result of several months experimentation with the circuit.* The illustration at the head of the article shows the complete outfit as used at station 2KV. The small cabinet at the left is an oscillator and will be taken up in the second part of this article. Figure 2 shows a photographic view of the outfit. This receiver is applicable to both loop and outdoor-antenna reception. Excellent results have been obtained during the past season on the broadcasting wavelengths. With an outdoor antenna, Pacific coast stations KZY, KSL, KFDB, KFI and KHJ were heard; the two latter were received often. On a two-foot loop WBAP, PWX, WOC, and WDAP were heard as well as many other nearer stations. The results on the 200-meter amateur wavelength were equally gratifying; this will be described in a following article. The set has a range from slightly lower than 200 to above 500 meters, and uses three vacuum tubes.

The Parts Used for the Set

¶ *The list of parts given at the head of this article includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

By referring to the various drawings it will be seen that the parts listed, corresponding to the letters in the diagrams, will be necessary for the construction of the outfit.

How to Construct the Set

We will start with the construction of the tuning circuit first. The tuning circuit is rather unusual; it makes use of a variocoupler, a grid or secondary loading coil and a variable condenser. This arrangement permits greater efficiency on short waves, as the loading coil is equipped with a simple dead-ending device. The use of an antenna condenser as an aid to sharpen the tuning of its own circuit is optional.

The primary of the variocoupler is wound on a 4-inch composition tube, 3 inches long. Drill the tube as shown in Figure 5. Wind

* This circuit won first prize at the Radio Convention at the Hotel Pennsylvania, New York, March, 1923.

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on the tube 48 turns of number 22 DSC. wire, starting the winding ½ inch from the bottom. A tap is taken off every eight turns.

The secondary is wound on a moulded composition ball of 3½ inches maximum diameter. It consists of 30 turns of number 24 DSC. wire wound 15 turns on a side.

The parts are now ready for assembly.

Cut two pieces of ¼-inch threaded brass rod 1¼ and 3 inches long respectively. Put three ½-inch, 6/32 flat-head brass machine screws in the three holes on the primary as shown in Figure 5. Solder the beginning of the primary winding to the lower screw.

Now take the two ¼-inch threaded rods and slip them through the two large holes in the primary tube, putting the long one in front. Fasten them with nuts to the rotor as shown in Figure 5. Put washers over the threaded rod between the primary and secondary so that the rotor will revolve accurately and will not wobble. The two ends of the secondary winding are soldered to the two threaded rods inside the rotor. From each of the top machine screws solder a flexible lead to the threaded rod. The two top machine screws are now the terminals of the secondary winding and the bottom screw is one of the primary terminals. The other primary terminal is the primary switch arm. Two mounting strips are made as shown in Figure 5 from ½-inch by ⅛-inch brass strip. They are mounted as shown and hold the variocoupler to the panel.

The grid loading coil is the next item of construction and is simply made. This is a composition tube 4 inches in diameter and 4 inches long. It is drilled as shown in Figure 6. On it are wound 100 turns of number 24 DSC. wire. Taps are taken every 10 turns. We are now ready to construct the shelf and the terminal panel.

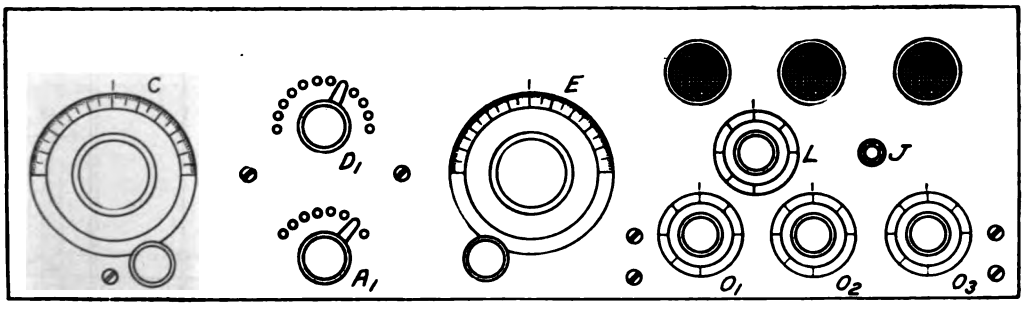
Two brass supports are made as shown in Figure 8 from ½-inch by ⅛-inch brass strip. The shelf consists of three parts; the tube shelf, the transformer shelf and the terminal panel. The 3-inch by 9-inch panel is drilled as shown in Figure 8. The two audio-frequency transformers are mounted on top together with the phone and bypass condensers. The radio-frequency transformers are mounted below the panel as shown in Figure 9. This method of mounting permits one machine screw to hold both the radio and audio-frequency transformers.

At this point it might be well to state that the author obtained best results with this set with Acme transformers in both radio and audio stages. For broadcasting, two R-2 radio-frequency transformers were used. If best amplification is desired between 400 and 500 meters the R-3 transformers should be used in place of R2's. For amateur wavelengths use an R-1 in the K1 stage and an R2 in the K2 stage in the circuit. The transformers can be easily interchanged.

The 2½-inch by 9-inch panel is drilled as shown in Figure 8. The three vacuum-tube sockets are mounted on the top of the panel with 6/32 machine screws. The grid leak is held underneath the panel by one of the socket screws. The three filament condensers and the grid condenser are mounted below the panel and are held in place by the wiring.

The dimensions of the terminal panel is 1 inch by 9 inches and is drilled as shown in Figure 8. It carries 8 binding posts for the antenna, ground, filament, detector and amplifier "B" batteries. No connections show on the front of the panel of the receiver. The shelf is now ready for assembly and is assembled as shown in Figures 2, 4, and 9.

The next job is to lay out and drill the main panel. This is 7 inches by 24 by ⅜ inches and is drilled as shown in Figure 7. The large 1⅛-inch holes for the tube bezels require a special tool to cut them and if the builder does not feel up to the job he can drill a series of small holes for the tubes, as described before in POPULAR RADIO. Care should be taken in drilling for the vernier knobs. The holes should be drilled so that the rubber tire on the vernier makes a snug friction fit with the edge of the dial. After drilling, the panel is rubbed with emery cloth or fine sandpaper to give it a grain finish. It is then polished with machine oil and a dry flannel cloth. The marks for the dial indicators are scratched in the panel with a sharp instrument, using a straight-edge to guide the tool. The scratches are then filled in with ordinary white, wax crayon.



THE LAYOUT OF THE FRONT PANEL

FIGURE 3: *This drawing shows in detail how the knobs and dials, the switches and the taps are mounted on the panel.*

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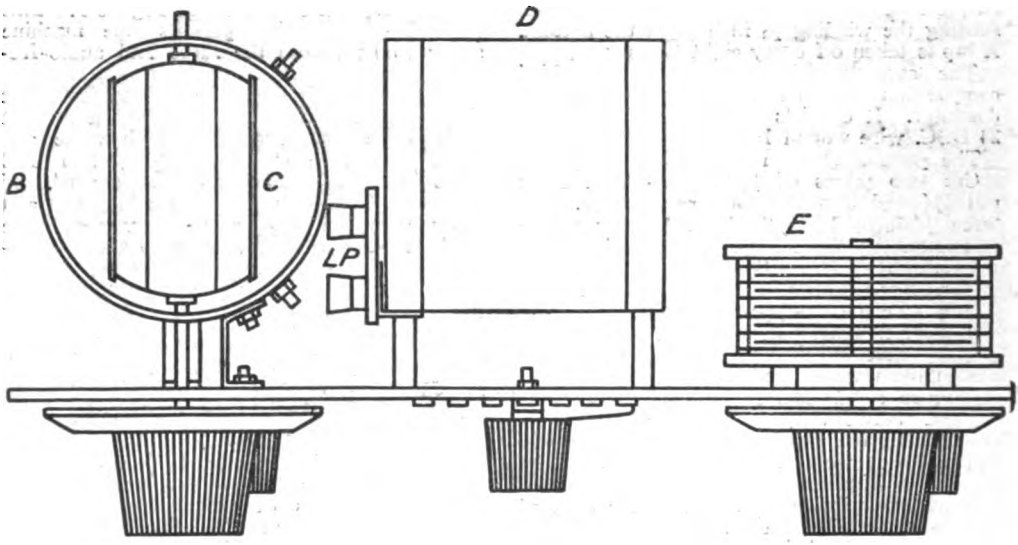


THE WORKING DRAWING FOR THE SET

FIGURE 4: *This view of the receiver (from above) gives a clearer idea of the arrangement of the parts and instruments.*

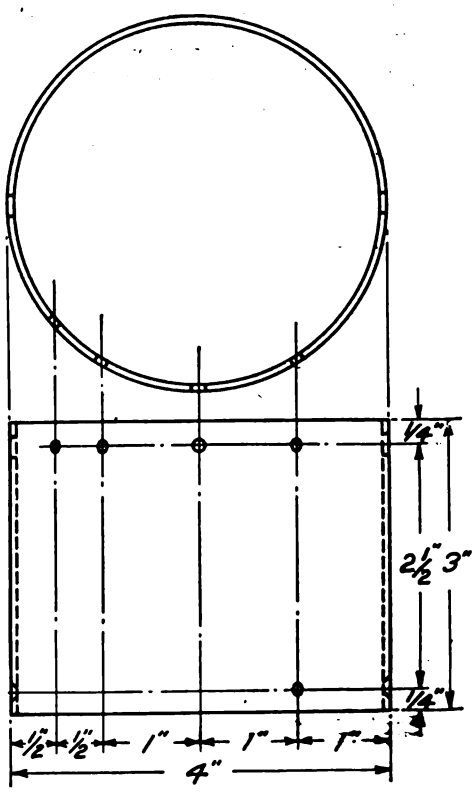
The various parts are now ready for assembly.

The variocoupler is mounted on the panel by means of the two brass supports with 8/32 flat-head machine screws. Leads are soldered to the primary taps and are made of No. 18 copper wire covered with empire tubing or "spaghetti." The six leads are connected to the lower set of switch points which are shown in Figure 3.

The grid loading coil is next mounted and is shown in Figure 6. Two pieces of ¼-inch brass tubing, 1 inch long, are cut and slipped over two 1½-inch, 8/32 machine screws. The loop terminal panel is now drilled as shown in Figure 6 together with a brass angle peice. The panel is of 2 by 2-inch composition. Four binding posts are mounted on the panel together with the angle piece. The hole in the angle piece is slipped over one of the long machine screws between the tube and the brass spacing tube as shown in Figure 6. The grid coil is held rigid by the long machine screws and the two brass spacing tubes. No. 18 wire leads covered with empire tubing are soldered to the taps on the coil and the upper set of switch points. A wire is soldered from the last switch point to the switch arm. This short-circuits the unused portion of the coil and in this way the arm acts as a dead-end switch.

The rheostats and potentiometer are now secured to the panel with 6/32 brass machine screws and the shelf is held to the panel by means of four 8/32 flat-head machine screws. The variable condenser and telephone jack are next mounted. The dials and switch arms should then be put on and the verniers adjusted.

The set is now ready for wiring.



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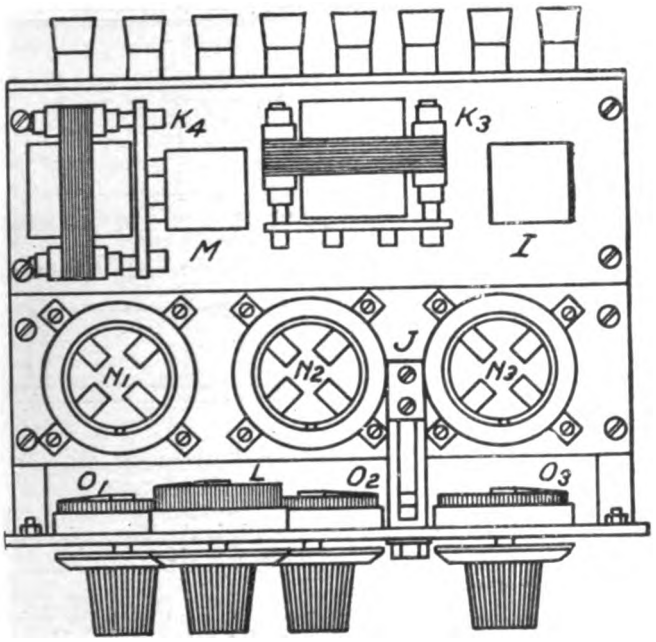

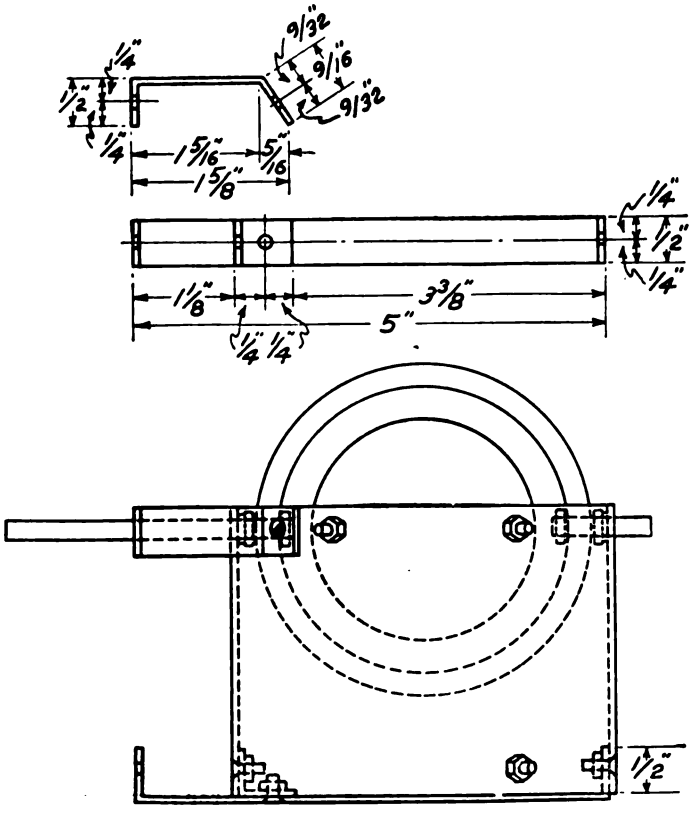

THE PARTS OF THE COUPLER

FIGURE 5: *These drawings give the details of the parts of the coupler. These parts may be made by the builder of the set.*

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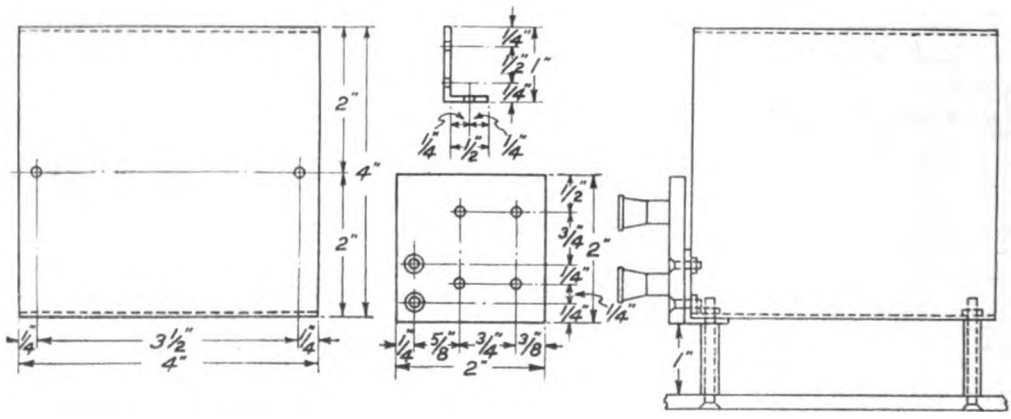


THE DETAILS OF THE GRID LOADING COIL

FIGURE 6: *This diagram shows how to cut the tube and panel, and gives the dimensions for drilling the holes for mounting.*

How to Wire the Set

Figure 1 is self-explanatory; it would be useless and confusing to attempt to describe how to connect this wire to that in a circuit as complicated as this. A few general hints will not be amiss, however.

Use the square tinned bus wire. It is easily handled and is very rigid.

The secret of wiring is orderly procedure. A circuit of this type appears to be hard to wire but if it is done in an orderly manner the job is completed in a surprisingly short amount of time. A great deal of time can be saved by removing the tube shelf and wiring it as a unit as far as possible. Start with the first tube and wire the radio-frequency amplifier, then the detector and finally the audio-frequency part of the system. Less mistakes are made in this way.

Mount the shelf on the panel and wire the rheostats and potentiometer. Then wire the tuning circuit.

In this circuit the secondary of the coupler is connected to one set of binding posts on the grid-coil panel. This is the lower set. The grid coil and condenser are connected to the top set.

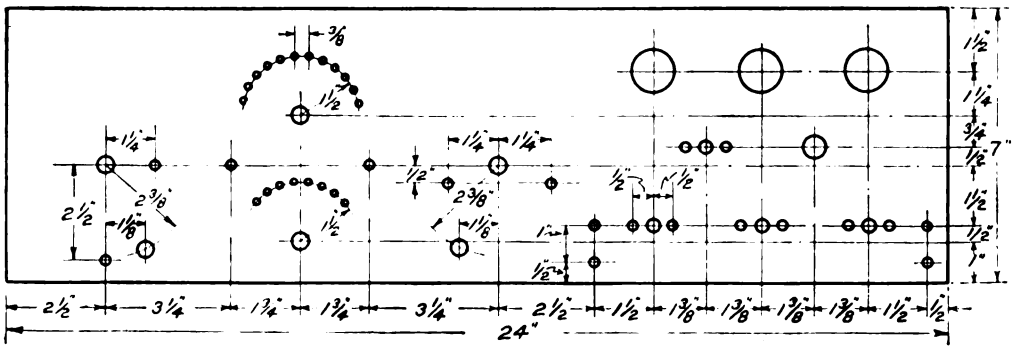
A neat wiring job shows up in the quiet operation of the set. Try and keep the radio and audio circuits as far apart as possible.

A standard 7-inch by 24-inch by 6½-inch cabinet may be readily purchased. A slot will have to be cut out of the back with a keyhole saw so that the terminal panel and binding posts will project through the back.

Operation of the Set

The first thing to remember in operating this set is that it is just like any other new set. The adjustments are rather critical; the set would not tune sharply if they were not. It takes about two weeks to a month to learn all of the tricks of operation but the results will be worth it. Do not light up the tubes and expect to hear KHJ the first crack.

For outdoor-antenna reception the Lp and Sec. binding posts on the grid-coil panel are connected together and the antenna is con-



HOW TO PREPARE AND DRILL THE MAIN PANEL

FIGURE 7: *This diagram gives the spacing for the drill holes for the instruments and the switches and switch points. The three large circular holes at the right are peep-holes for the tubes.*

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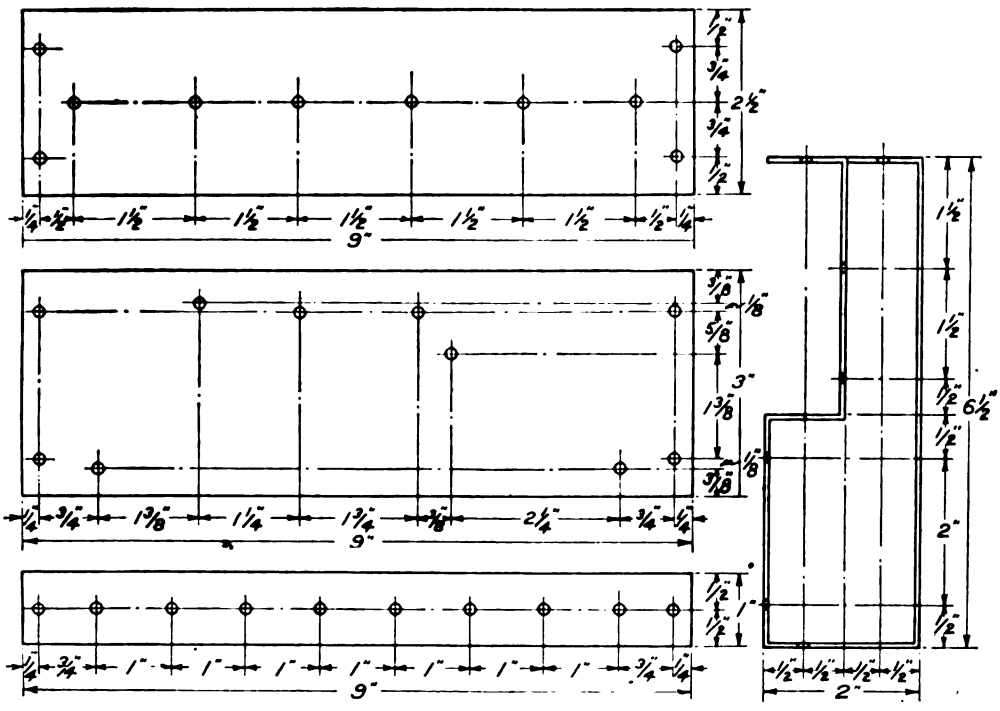

THE DIMENSIONS FOR THE SMALL PANELS AND BRACKETS

FIGURE 8: *The sizes for the composition panels are given above, together with the correct spacings for the drill holes for mounting the instruments and the binding posts. The specifications of the brackets are also given.*

nected to the regular terminal on the rear terminal panel. For loop reception the grid-coil binding posts are disconnected and the loop connected to the top set of posts. Only the grid coil and secondary tuning condenser are now in use.

The set is functioning properly when a high metallic sound is heard as the amplifier tubes are turned up. If this is not heard, try adjusting the potentiometer until it is heard. The potentiometer is usually worked with its lever at the negative end of the filament. A dull roar is heard when the detector filament is turned up. The set should howl when all the resistance is cut out of the filaments and the potentiometer is at the negative end of the filament. The howl can be controlled either by the filament rheostats or the biasing potentiometer. The latter method is more advisable.

To tune the receiver, set the coupler dial at about 45 degrees and use full primary inductance. Use about half of the secondary inductance and tune with the secondary condenser until the station is brought in. If you find a great deal of capacity is used, increase the grid inductance and decrease the amount of capacity used. It is always best to use a small amount of capacity and a large amount of inductance.

When the station is finally tuned in, the set can be checked by the following test:

Remove one of the amplifier tubes at a time. The set should go dead. With the amplifiers going, remove the detector tube. The signals should not be heard at all (or very faintly). If this is *not* the case then one of the amplifier tubes is detecting and should be replaced. A good reflex is largely a matter of proper tubes. The author has obtained best results with this set by using G. E. VT-14 tubes as amplifiers and a UV-200 detector. Good results were obtained with two UV-201's as amplifiers and excellent signals were obtained with a UV-201, 202, and 200 combination. The latter, however, is quite a drag on the filament battery. The second combination is the best for general use. The author has found several UV-201 tubes that were good detectors and did not work properly in the amplifier stages. UV-201 tubes are not quite as well suited for this work. WD-11 and UV-199 tubes may be used in this circuit. KZY was heard using three WD-11 tubes.

About 90 to 112 volts is right for the amplifier "B" battery, using 22½ volts for the detector tube.

Use good tested mica condensers for the filament bypass condensers. They receive the full voltage from the "B" battery and should be built to stand the voltage.

If the directions given are adhered to

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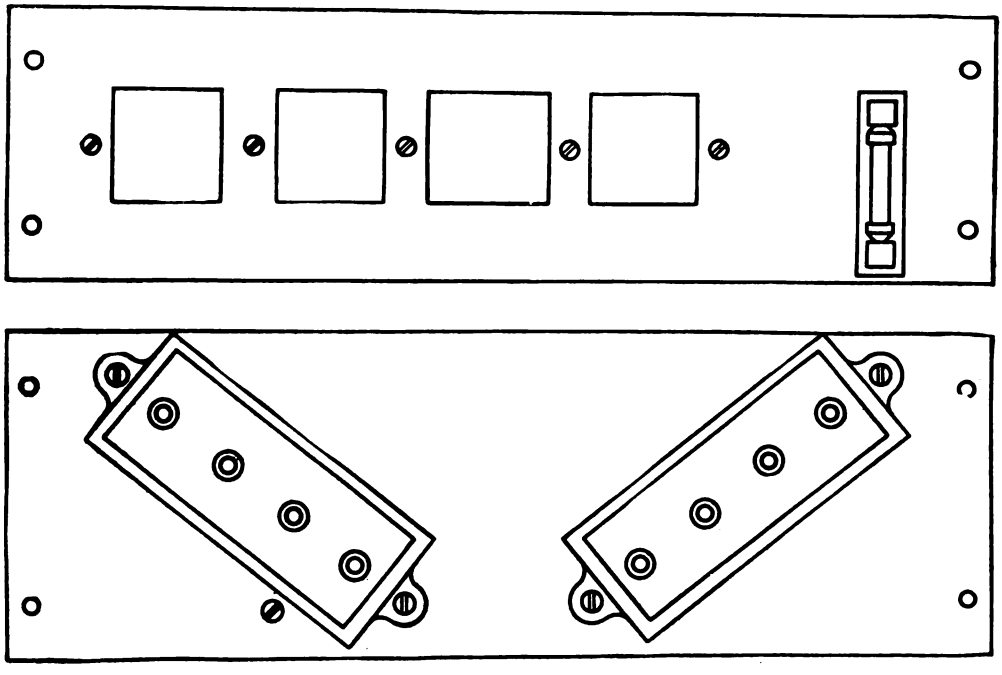

A VIEW OF THE TWO SHELF PANELS, SEEN FROM BELOW

FIGURE 9: *This drawing shows how the two radio-frequency amplifying transformers are mounted on the bottom of one panel and how the mica condensers and the grid leak are mounted on the bottom of the other panel strip.*

and the constructor takes pains in the construction of the set he will have a receiver which will give him satisfaction both in DX reception accomplished, quality of speech, and in mechanical design. It is advisable that the constructor should have had previous experience with vacuum-tube sets as a reflex receiver is quite a project for a first attempt.

As will be noted, the circuit is a *non-regenerative* one. It is practically impossible to secure regeneration by the tuned plate method in a reflex receiver without causing the set to howl. In the opinion of the author, for broadcast reception the non-regenerative receiver is best because it does not distort the voice. While a reflex theoretically should give some distortion it has been found that this circuit gives a fine mellow quality. Everyone, without exception, who has heard the receiver here described has commented upon its pleasing tone-quality.

On low waves, where amateur CW transmitters are received, some form of heterodyne is necessary. The best way to accomplish this is to use an external oscillator, which is shown in the small left-hand cabinet in the illustration. This exceedingly useful instrument will be described and the application of the reflex receiver to amateur reception will be taken up in the second part of this article.

¶ PART II *of this article will give full instructions for building a single-tube oscillator in which the frequency of the oscillatory currents generated can be controlled. This oscillator may be used in connection with the receiver that has just been described, to allow of reception of amateur CW signals by the heterodyne method. Every radio experimenter should own an oscillator of this type.*

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A Tube without a Filament

Here is the new ionization tube (called the "S" tube) that has no filament to burn out and no filament current—and which consequently requires no rheostat. How this tube is made and how it is used for rectification is described in this article.

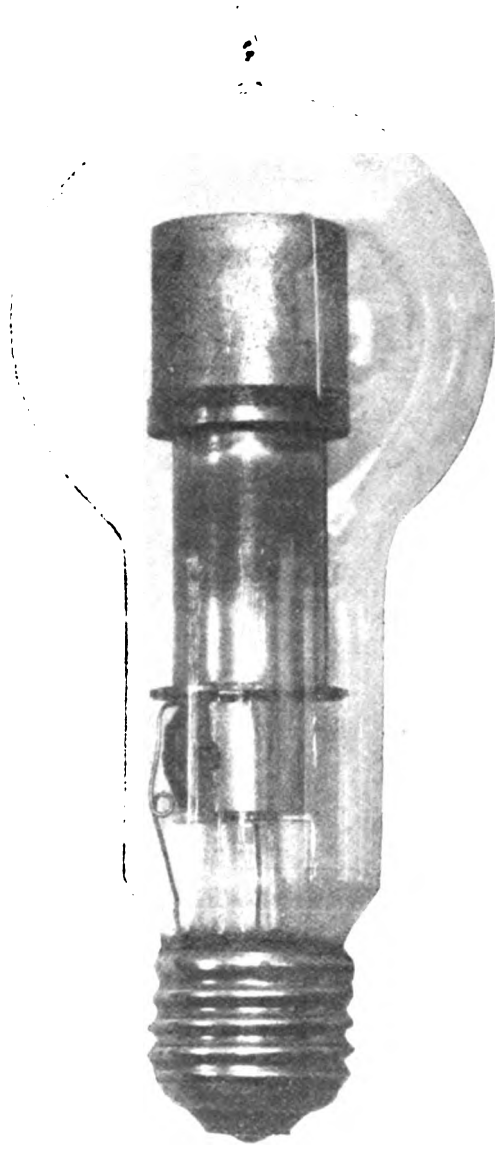
By JULIAN K. HENNEY

THE past few years have witnessed the evolution of the vacuum tube from a family of one member—the prewar tubular audion—to a large and growing household. The family has extended itself in both directions, for the genus "vacuo" now includes everything between the tiny "peanut" variety, which burns with such a feeble glow as to be nearly invisible, and the giant tubes that have been described in POPULAR RADIO.

Between these two extremes are many tubes with many names and performing many useful functions. There is the Tungar which charges our batteries while we sleep; another important member of the family is the Kenotron, which gives us direct current from alternating for broadcast stations; then there is the great Coolidge tube that produces the mysterious and penetrating X rays of increasing importance in medicine.

A dry battery has sufficient energy to sustain life in the latest peanut tube for many hours, for only six hundredths as much current is required for this tiny device as for its ancestors. At the other end of a long line of tubes lie those monster brothers of the audion family which are able to handle as much as 100 kilowatts of energy—enough to supply a fair sized village with electricity—and 100,000 times as powerful as the lowliest member of the group.

Somewhere between these two limits is the tube without a filament, known as the "S" tube after the name of its inventor, Mr. C. G. Smith.



At first thought, a vacuum tube without a filament seems to be in the same category as a "ship without a sail," but such a tube does exist and paradoxical as it seems, it works.

In radio parlance, a vacuum tube means an evacuated vessel in which are two or three elements, a plate, a filament, and perhaps a grid. The action of the instrument depends upon the presence of electrons which are furnished by the heated filament. Thus it would seem that the filament would be the first

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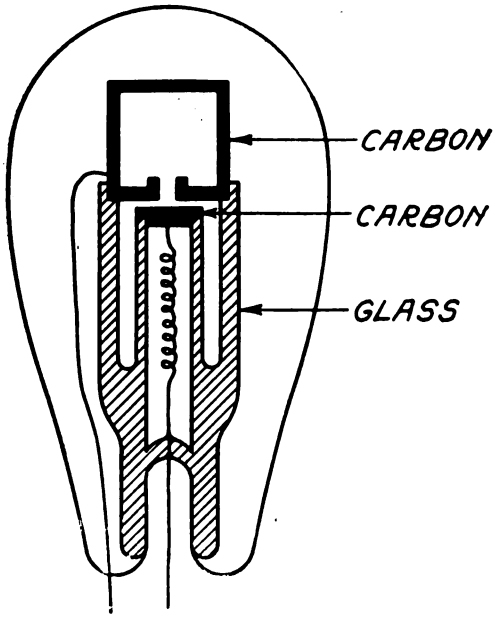
essential of a workable vacuum tube.

Yet while we have loafed along, content with tubes that require batteries, the electrons have not been idle; in fact, they are always waiting for some enterprising and inventive genius to discover some new modes of making use of their limitless capabilities. This time they have demonstrated that a vacuum tube does not necessarily signify a lighted filament shooting off electrons into the surrounding vacuum.

In order to understand the action of this new type of tube, we must remember that our friends the electrons are always present in matter, regardless of the state in which that matter may exist, solid, liquid, or gaseous. Some of the minute electrons in solids are held tightly in place in the atoms that compose the matter, and some of the electrons are free to move about, fenced in between their brothers which are held fast. In liquids the free electrons have more freedom, for the atoms themselves move about. In a gas, the free electrons have still greater liberty, and are able to roam around among the heavier atoms of gas.



HOW THE TUBE IS BUILT

The general construction of the tube is shown in this diagram. Note the peculiar opening in the large upper electrode.

If, then, a small quantity of gas is sealed in a glass tube that contains two electrodes, a few electrons—a hundred million or so—will be shut in also. A positive potential applied to one of the electrodes would attract the electrons, as these latter are negative charges of electricity, and a drift of these minute charges would take place. Owing to the presence of the gas atoms, which are at least 1,800 times heavier than the electrons the latter will have much difficulty in finally reaching the positive plate for they will continually bump up against atoms and thereby lose their momentum.

By increasing the potential on the positive plate we can speed up the electrons, and by pumping out some of the gas we can provide a freer space in which they can move about. Thus an electron can move further before colliding with one or more of these huge atoms in a space which is comparatively free of the larger particles. As a result it will have a greater chance to get up speed before losing its momentum in a collision.

By placing a still higher potential on the plate and pumping out more and more of the gas atoms until a very good vacuum is reached, the electrons will attain enough velocity to cause some damage to an atom which happens to be in the way. As gas atoms themselves consist of a heavy positive nucleus and a certain number of electrons—one in the case of hydrogen—we can see that a high-velocity, free electron may disrupt an atom, dislodging its electron and leaving a positive part behind. Thus there are two electrons instead of one, both hurrying on their way toward the positive electrode of the tube, bumping into more gas atoms as they proceed, releasing more and more of their fellows from captivity. Thus the action goes merrily on, or as the scientists say, the action is "cumulative," which means that after the first successful collision takes place, liberating one electron, many more may follow and the

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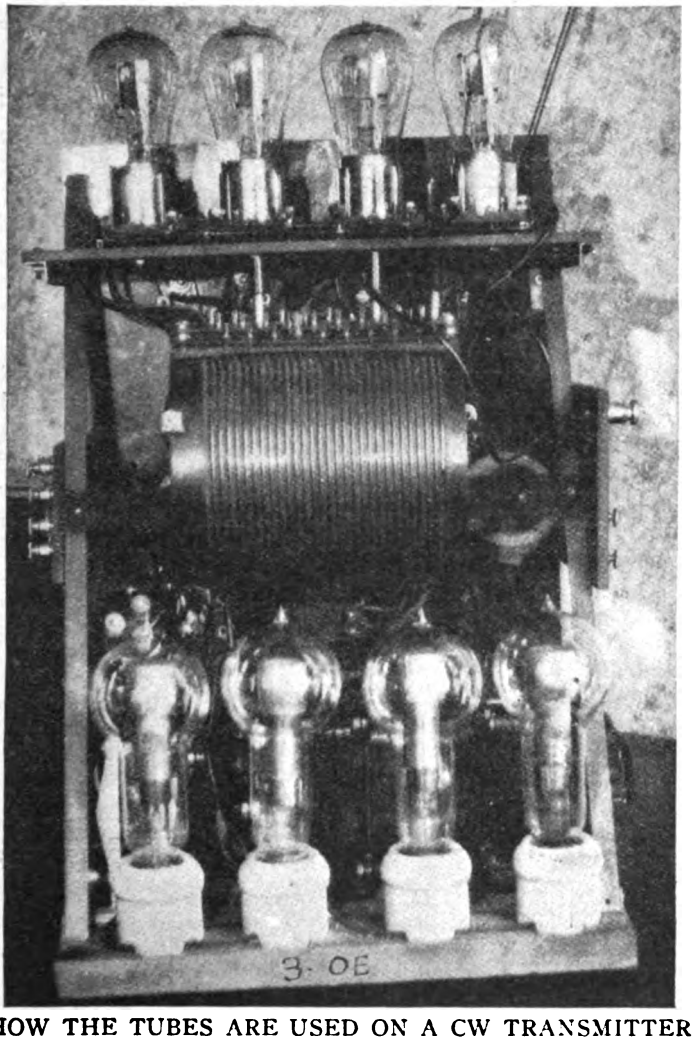

HOW THE TUBES ARE USED ON A CW TRANSMITTER

Four of the "S" tubes mounted in the CW transmitter used by Station 3OE. They are used to change the alternating current from the power transformer to direct current, for supplying the plates of the oscillators with energy.

total number of freed electrons builds up and up.

In this manner a current of electricity may be carried from one electrode to the other by these invisible carriers, and, as one might suppose, the more carriers the greater the current. As a matter of fact, it is said that at least five collisions are necessary for a continuous current. No successful collisions take place until the attainment of a potential of a certain value, depending upon the gas, and known as the "ionization potential" of the gas. For instance this quantity for hydrogen is 13.6 volts, and for helium 29 volts. Up to the point where ionization takes place the velocity of the electrons is not sufficient to cause another carrier to be liberated.

In connection with currents through evacuated vessels, it is important to note that the distance between electrodes plays a conspicuous role. In air, and under ordinary pressure, the farther two electrodes are apart, the greater voltages it requires to maintain even a small cur-

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rent across the gap. In a vacuum tube only a small current will flow unless the distance between the electrodes is large—in exact opposition to what happens in air.

When the electrodes are close together only a few electrons carry current across. By increasing the distance, or the path the electrons travel, they may get up enough momentum to batter other carriers out of gas molecules en route.

For instance, a tube may have two paths for the discharge to take place, one a short path and the other a more circuitous route. The greatest current will follow the longer path. This is due to the fact that the bulk of the current is carried on liberated electrons produced by ionization by collision.

This relation between electrode distance and current flow is important in the theory and action of the "S" tube.

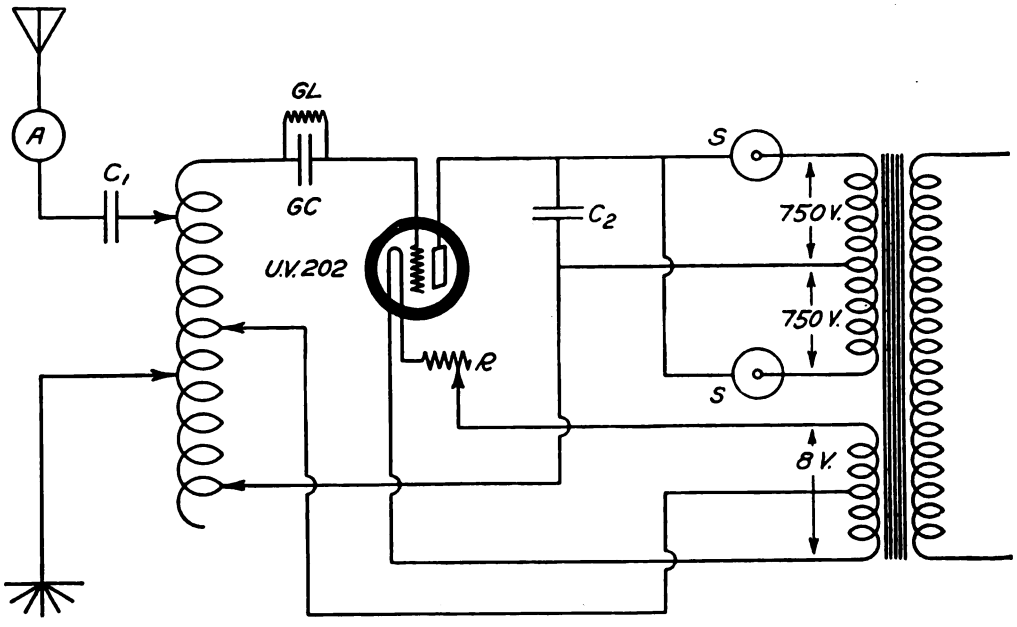
Lowering the gas pressure in a tube decreases the total number of gas atoms present, and provides a greater space for the speeding electrons to move in. Increasing the potential applied increases the attraction of the positive plate for these tiny charges, and placing the two terminals further apart gives the charges time to get up to the minimum speed for dislodging other electrons from gas atoms and molecules.

An alternating potential applied to the tube will send the electrons back and forth through the space, and the atoms will be bombarded on all sides. If some means could be provided so that ionization by collision would take place only when one given terminal were positive, current would flow in only one direction through the tube instead of back and forth. Thus the device could be used as a rectifier, changing alternating current to direct.

So thought Mr. C. G. Smith who became interested in research in this direction* with the result that the new filamentless tube was developed.

To understand what takes place within

*In the laboratories of the American Radio and Research Corporation.



HOW TO CONNECT UP THE "S" TUBES AS RECTIFIERS

This wiring diagram shows the proper way to connect up the filamentless rectifiers to a power transformer and an oscillating circuit. The oscillating circuit shown is the Hartley.

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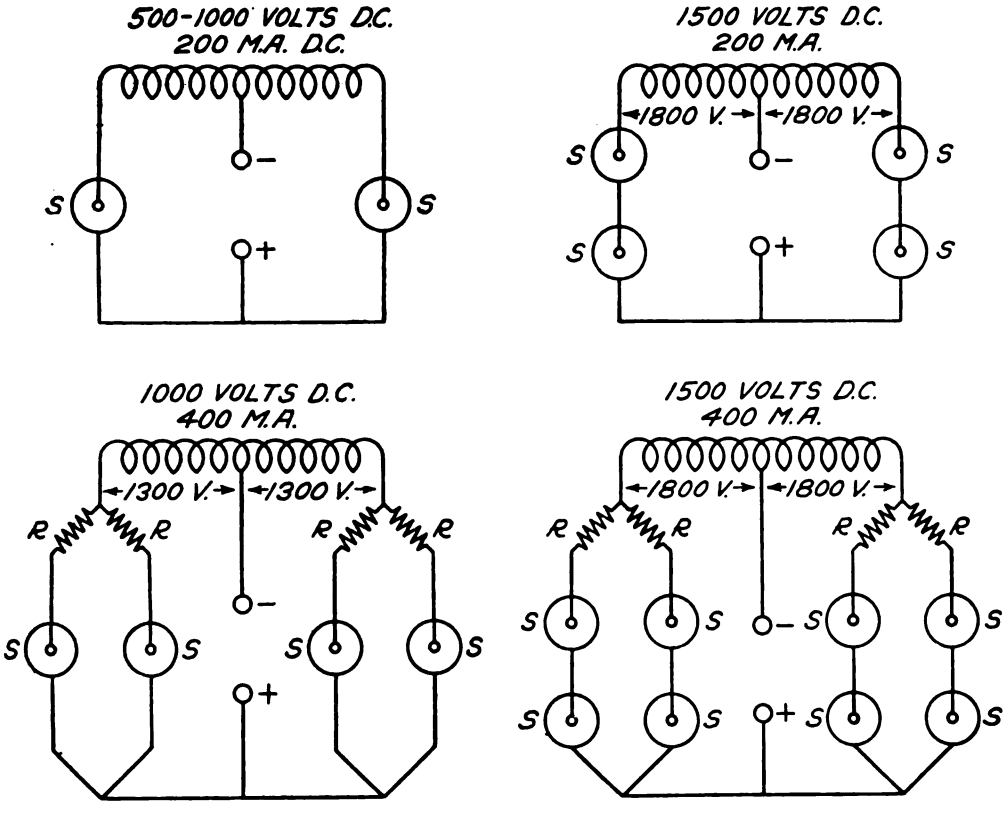

FOUR WAYS TO USE THE "S" TUBES

These four diagrams show how to connect up the "S" tubes to the secondary terminals of power transformers of different types to get different outputs in voltages and currents. The first circuit arrangement (upper left) will give a current of 200 milliamperes at 500 to 1,000 volts D.C. The second (upper right) will give a current of 200 milliamperes at 1,500 volts D.C. The third (lower left) will give 400 milliamperes at 1,000 volts and the fourth (lower right) will furnish 400 milliamperes at 1,500 volts D.C.

this tube, let us see what happens when an electron bumps another electron out of a gas atom. The two electrons are still attracted toward the positive plate although they may be thrown off their course by the collision that produced the second carrier. The remainder of the atom, the heavy positive part, is attracted toward the negative plate. Owing to its greater size and weight, its velocity toward its respective goal is relatively slow. If the potential is suddenly reversed, the electrons turning toward the new positive plate will run into a cloud of positive remains of disintegrated atoms. It is this relative mobility of the two carriers, negative electrons and positive gas ions, that Mr. Smith has utilized in the development of the "S" tube.

Instead of using two metal electrodes for the terminals of the new tube, the general shape of the device is as shown in the illustration on page 178. When connected to a source of alternating current one terminal and then the other is alternately made positive. When the cup-shaped electrode is negative, electrons will be attracted towards the flat-surfaced anode from all parts of the cup. As the distance from inside the cup, out through the restriction to the positive terminal, is longer than that required for ionization by collision, gas atoms will be broken up by the speeding electrons

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and a steady current will flow across.

When the cup is positive, a different action takes place. The positive ions, moving slowly, because of their greater mass—like a heavy football player—gather near their points of emission in a kind of fog, termed a "positive space charge." The negative electrons are attracted to the positive plate, but only a few manage to get through the positive space charge. Those few which succeed in getting into the cup are engulfed in the cloud of sluggish positive ions, the remains of previous atomic disintegrations, and their effect is neutralized. Thus it is seen that current can flow through the tube in only one direction, and that the device acts as a rectifier, changing alternating current into a pulsating current traveling from one plate to the other, but not in the reverse direction.

Two tubes properly placed in an alternating-current circuit rectify both sides of the cycle, and instead of a jerky flow of electricity, we can get a more uniform passage, comparable to that generated by a direct-current dynamo. If the proper "filters" are used, the final product will be direct current which may be used for radiophone or telegraph transmission.

Unlike most tubes, the life of this device is not limited by the life of a fragile and disintegrating filament. The safe limit of current through the tube is about 100 milliamperes, and for heavier currents several "S" tubes may be placed in parallel. Thus the device is useful in rectifying the output of high-voltage transformers for radio-telegraph or telephone transmission. For voltages higher than a thousand a single tube may be replaced by two in series as shown in the diagram of connections.

The "S" tube, as produced at present, may be used for charging storage "B" batteries as well as high voltage for the plates of amplifying tubes.

The construction of the tube is typical of all vacuum-tube manufacture. The elements are assembled by hand and enclosed in the outer bulb. A seal is made then between this bulb and the slender glass neck that carries the two wires outside. The device is pumped as free from gas as possible while the elements are subjected to a potential of 800 volts and the entire tube is heated in an oven.

Even with the lowest pressure to which it is customary to pump ordinary vacuum tubes, there remains a vast number of gas molecules swarming about within the space. Professor Morecroft* estimates that "it is likely that in the highest vacuum tubes used today (10^{-8} mm of mercury) there are of the order of 100,000,000 gas molecules per cubic centimeter." The pressure in mercury referred to corresponds to about 8×10^{-15} pounds per square inch—about 8 thousand million millionths—which is not a very great pressure.

When the "S" tube is sufficiently exhausted, helium is admitted until the pressure is about 12 mm of mercury. Helium is an inert gas, that is, it will not react chemically with other elements. It provides the necessary atoms for the process of ionization by collision.

Now that we have a tube that functions without a filament, who knows what the electrons will show the radio engineer next?

*In his book "Principles of Radio Communication"

Is Your Receiving Antenna Put Up Correctly?

UNLESS *it is, you cannot get the proper value from your receiving set, no matter how efficient that set might otherwise be. How to install an ordinary single-wire, outdoor receiving antenna—and install it right—will be told in the March number of* POPULAR RADIO.

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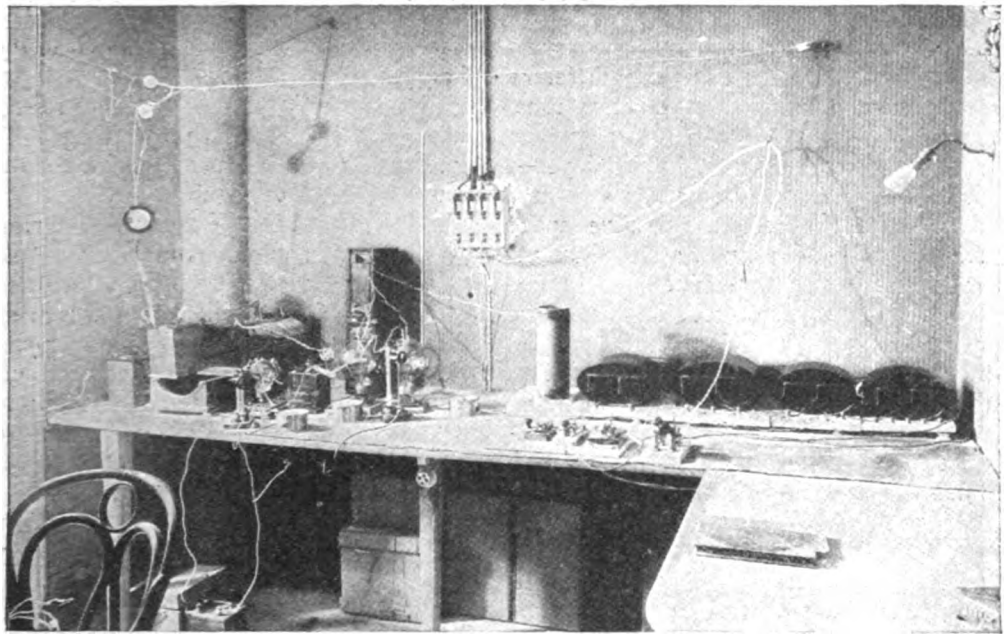

THE FRENCH AMATEUR TRANSMITTER THAT REACHED AMERICA

The two 250-watt tubes are just left of the center. To the left are the condensers for the counterpoise and the antenna, the vacuum-tube grid-leak and the inductances. To the right are the transmitting keys and the transformers.

Across the Atlantic on 100 Meters

Captain Leon Deloy of Nice, France, is not only one of the best-known radio amateurs in the world but also is President of the Radio Club of the Côte d'Azur and one of the most capable of radio engineers. Many American amateurs will remember Captain Deloy's service in this country in the latter part of the World War, when he was attached as a radio expert to the French Military Commission in America.

By LEON DELOY

ON November 27, 1923, amateur radio spanned the Atlantic in two-way communication for the first time in history. Captain Leon Deloy, of Station 8AB at Nice, France, exchanged a series of messages with the well-known American amateurs Mr. F. H. Schnell and Mr. John Reinartz. Last year, just as he was leaving the United States to return to France, Captain Deloy said to the Technical Editor of POPULAR RADIO, "I am going back and work America on one hundred meters." He did it. In this article, written especially for POPULAR RADIO, he tells how it was done.

The accompanying simplified diagram shows the connections of the main pieces of ap-

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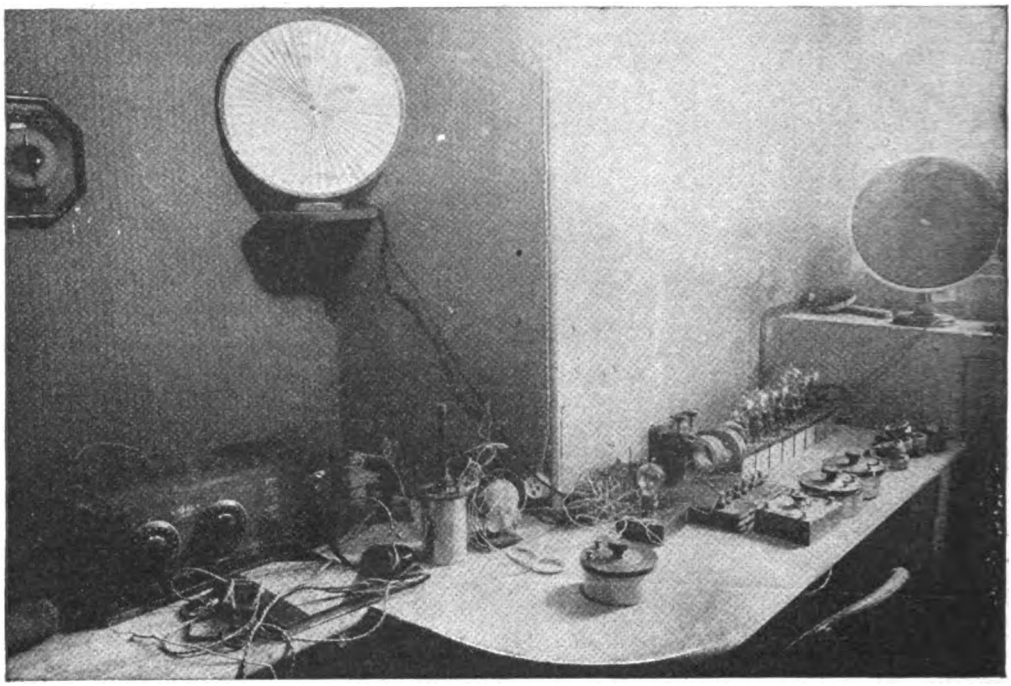
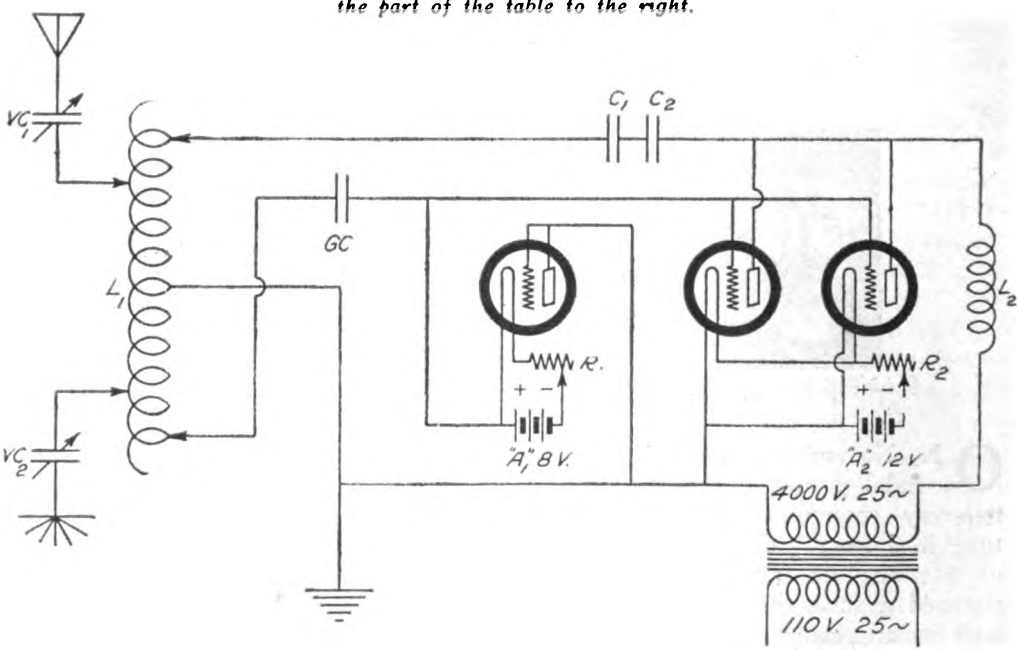


RECEIVING EQUIPMENT AT DELOY'S STATION IN NICE

The receiver at the left, directly under the disk of the loudspeaker, is the Grebe No. 13. The home-made super-heterodyne which Captain Deloy also used is on the part of the table to the right.



THE CIRCUIT DIAGRAM FOR THE DELOY TRANSMITTER

This arrangement, designed by an American, John Reinartz, is the one used in the transatlantic transmission. The two transmitting tubes are on the right of the diagram, the third tube being the grid-leak.

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paratus employed in my station during the recent two-way communication tests carried on with American amateurs.

The antenna is a four-wire cage, ten meters long and one meter square, about twenty-five meters above ground. The down lead is taken from one end and consists of two wires two inches apart. The counterpoise is a four-wire cage, one meter square and a few meters longer than the antenna. It goes downward from the window of the operating room (which is located about ten meters above ground) to a point two meters above ground. It is nearly underneath the antenna.

The antenna and counterpoise run in a north and south direction with their insulated ends toward the south. Both the antenna and counterpoise are made of seven-strand copper cable, each strand being enameled. The variable condensers in the antenna and counterpoise are Cardwell transmitting condensers and are always kept on the same reading.

This particular combination of antenna and counterpoise with two condensers is due to Mr. John Reinartz and is certainly very efficient.

The ground system is composite: water, gas and steam pipes, lightning rod, tin roof and about eighty meters of wire fence buried in the garden mostly under the antenna. A Jewell thermocouple ammeter is used in the antenna circuit. During the tests referred to the reading was between 2.3 and 2.8 amperes. The helix is home-made with copper tubing. All the fixed condensers are home-made from photographic glass plates.

Two ¼ KW. (input) S. I. F. French tubes are used in parallel. The filaments are heated by a twelve-volt storage battery with a rheostat in series. The Chauvin and Arnoux voltmeter and ammeter connected in the filament circuit read 5.5 volts and 14 amperes. The plates are connected through a home-made choke coil to the secondary of a 4,000-volt transformer. (In practice several transformers are used with their primaries in parallel and their secondaries in series.)

The key is in the primary of the high-tension transformer. As a grid-leak I use the plate-filament space of a 50-watt (input) S. I. F. tube the filament of which is heated by an 8-volt storage battery. This filament draws 2.5 amperes at 6 volts. Its temperature and consequently the plate-filament resistance can be varied by a rheostat, which is extremely useful in working the main tubes at their best efficiency. This grid-leak device is due to Mr. Thomas Appleby.

Although, as this is written, I have been testing with America only for the last three nights, my signals have been received there regularly and strongly. Last night (November 27) two-way communication was established for the first time in the history of radio between amateur stations of the two continents when I exchanged messages and long conversations with Mr. Fred H. Schnell and Mr. K. B. Warner of 1MO and Mr. John Reinartz of 1XAM, who reported my signals as readable on the loudspeaker and twenty feet from the phones.

For reception I use either a Grebe CR 13 receiver, which is proving very efficient and practical, or a home-made super-heterodyne which gives me regularly the voice of KDKA readable six feet from the phones with only one step of audio amplification.

With a given number of tubes the signals from 1MO are the loudest American signals I have heard so far, including all amateurs heard during last year's transatlantic tests and all the high-power stations.

THE HIGHEST RECEIVING STATION IN NEW YORK STATE

The tallest mountain in New York state is Mount Marcy, 5,344 feet above the sea. A receiving set was carried to the top recently by Hall E. Shepherd and Sherwood Marvin, an antenna wire was stretched between two boulders and concerts from WGY, WEAF and WMAF were picked up.

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HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

How the Anti-trust Laws May Affect the Radio Fan

UNDER a request from the House of Representatives for information that would aid in determining whether or not the anti-trust laws of the United States were being violated, the Federal Trade Commission has made a careful investigation of the radio industry. The report of the Commission, recently submitted to Congress, will probably prove one of the most important documents ever issued for the radio industry. The following quotations include some paragraphs of the report that are of especial interest to the amateur and the broadcast listener.

After outlining the history and present stock ownership of the Radio Corporation of America the Commission continues:

"The Radio Corporation has entered into agreements with the various companies which own or control practically all patents covering radio devices considered of importance to the art. The number of patents involved approximates two thousand. Agreements of this character have been entered into with the General Electric Company, Marconi's Wireless Telegraph Company, Ltd., American Telephone & Telegraph Company and its subsidiary, the Western Electric Company, the United Fruit Company and its subsidiary, the Wireless Specialty Apparatus Company, The International Radio Telegraph Company, the Westinghouse Electric & Manufacturing Company, and the Radio Engineering Company of New York. With certain minor limitations, the Radio Corporation under these agreements has secured an exclusive divisible right to sell and use the radio devices covered by the patents involved or by patents which these companies may acquire before the termination of the agreements. The agreements with the American Telephone & Telegraph Company and the Western Electric Company are to terminate in 1930, while the remainder are to terminate in 1945. Provision is made for the mutual exchange of information relating to radio, and, in most instances the Radio Corporation has granted to the other company a license under its patents to make and use devices in the particular field in which the other company is interested.

"The Radio Corporation, under these agreements, is made the selling company for practically all radio devices to be sold to the public under the hundreds of patents involved. The General Electric Company and the Westinghouse Electric & Manufacturing Company are to manufacture and to sell to the Radio Corporation only, these devices and apparatus, the Radio Corporation agreeing that sixty percent of its annual requirements would be purchased from the General Electric Company and forty percent from the Westinghouse Company. Until the expiration of the Fleming patents in 1922, the Radio Corporation had an absolute monopoly in the sale of vacuum tubes. On the expiration of these patents, the DeForest Radio, Telephone & Telegraph Company, which had retained a right to manufacture and sell, commenced the sale of such tubes to the general public. In the sale of receiving sets, the Radio Corporation has competition from seventeen concerns licensed under the Armstrong patents, although their sale of sets for use in conjunction with tubes is being contested in the courts at the present time."

The Commission then proceeds to analyze the situation with regard to ship-to-shore and international communications. With regard to the latter the Commission states:

"The Radio Corporation is the only concern now engaged in transmitting and receiving radio

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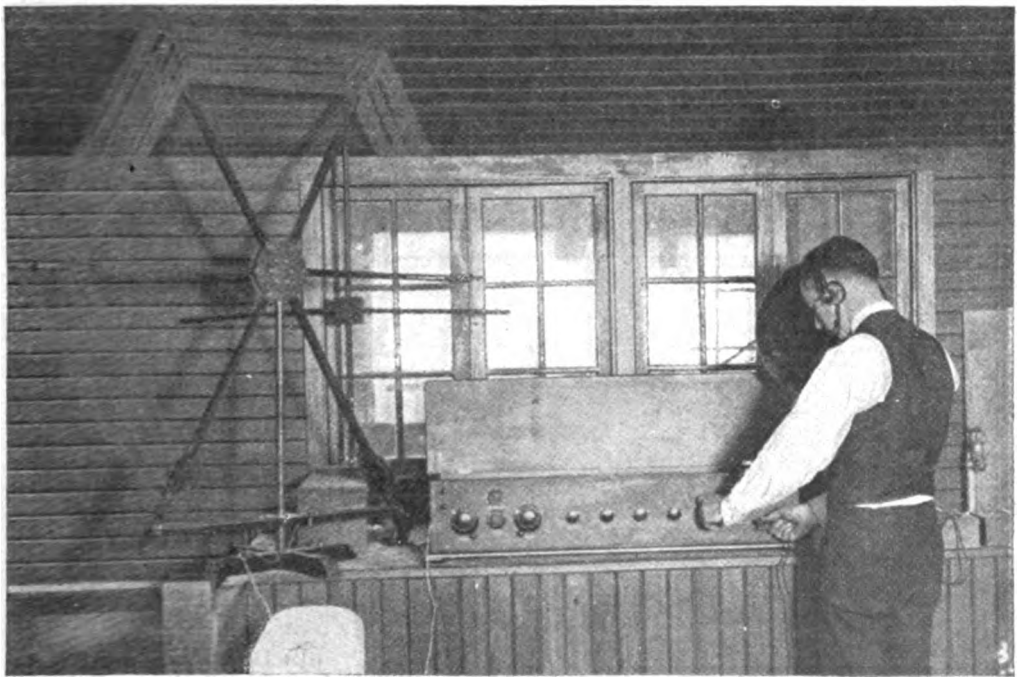
messages between the United States and foreign countries and contends that in order to function properly it must of necessity secure a monopoly in this field. The company has secured a virtual monopoly and controls all the high-power stations with the exception of those owned by the Government."

In conclusion, under the head of "Sale of Apparatus" the Commission continues:

"The refusal to sell or lease apparatus to competitors for international communication purposes is included in the well-defined policy of the Radio Corporation of America. It also affixes to the apparatus sold a license notice, the object of which is to restrict the purchaser's use of the device to amateur and experimental purposes. In supplying ships with apparatus, devices and appliances, the shipowners are required to execute an agreement which provides that the apparatus, etc., furnished by the Radio Corporation is licensed only for use on board ships and aircraft in communications destined to or originating on such ships or aircraft.

"The Radio Corporation distributes its products chiefly through wholesale concerns handling electrical supplies. In order for a distributor to handle these goods it must furnish evidence that it has the facilities for conducting a wholesale business and give an initial order amounting to not less than $25,000. Independent manufacturers of sets are not sold vacuum tubes and other patented devices for resale in connection with sets manufactured by them. This was a hardship, particularly when there was a shortage of tubes, as the dealers were unwilling to furnish them with tubes. The investigation shows that the shortage in tubes was confined to three of the six types manufactured and prevailed during 1922 and first few months of 1923. There was a marked increase in the demand for tubes as the industry developed, as is shown by the orders received by the Radio Corporation, which were as follows: 1921, 112,500; 1922, 1,583,021; and for the first nine months of 1923, 2,931,262 tubes. Although the officials of the Radio Corporation admit that they do not carry dealers who confine their orders to tubes exclusively, there is little evidence that the Radio Corporation required dealers to handle their goods exclusively or favored such dealers, in the supply of tubes, as compared with dealers who also handled apparatus manufactured by others.

"The DeForest Radio, Telephone & Tele-



Underwood & Underwood

AMERICAN RADIO AMATEURS PICK UP EUROPEAN BROADCASTING STATIONS

A special loop antenna, presented to Arthur Lynch, editor of ***Radio Broadcast,*** *by Dr. J. H. Rogers, the man of "underground-antenna" fame, was used in conjunction with this super-heterodyne receiver to pick up the European broadcasting stations' signals in a recent test held at Garden City. A number of the transatlantic signals were recorded by amateurs. In a short time we will all be listening in to broadcasting from across the water.*

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graph Company, which is now engaged in the manufacture and sale of a modern vacuum tube, also affixes to its product notices with respect to use similar to those used by the Radio Corporation. This company has recently adopted the policy of making the distributors of its products, agents.

"The Commission submits no conclusions in this report as to whether the facts disclosed constitute a violation of the anti-trust laws, as the House resolution under which the report was prepared called only for the facts and data 'as in the opinion of the Commission may aid the House of Representatives in determining whether . . . the anti-trust statutes of the United States have been, or now are, being violated . . .; and such other facts as in the opinion of the Commission may aid the House in determining what further legislation may be advisable.'"

Useful Hints on the Test Buzzer

TO the beginner who is enjoying local broadcast programs through the medium of the useful and inexpensive crystal set, the following information will be of real value:

If a vibrating buzzer circuit is placed in inductive relation to either the open or closed circuits of a receiving set, the fluctuations of the battery current act inductively on the receiving circuits and set up therein feeble currents which are rectified and made audible in the head telephones.

The maximum response in the head telephone is obtained when the crystal is adjusted for the best degree of rectification (or is on the most sensitive spot); hence the buzzer affords a ready means for adjusting the detector. A perfect reproduction of the tone of the buzzer is obtained in the phones, the pitch varying in accordance with the interruptions of the vibrator.

The method of placing the buzzer in inductive relation to the antenna system is shown in Figure 1. The coils L3 and L4 are wound on a tube 1½ inches in diameter and 1¼ inches long; L2 is wound with 8 turns of No. 20 D.C.C. wire; L1 is wound with 6 turns of the same size of wire. The coil L1 is connected in series with the battery and the buzzer, and consequently when the buzzer is set into action, a change of flux takes place through L3 which sets up a difference of potential across L4 and, therefore charges the antenna system, causing it to oscillate at the particular frequency to which it is adjusted. Then, when the secondary circuit of the receiving tuner is adjusted to resonance with the antenna circuit, and the crystal detector is adjusted for the most sensitive operating condition, the loudest sound will be obtained in the phones.

The coils L3 and L4 may be placed either inside or outside of the receiving cabinet. They may be installed inside the cabinet and a pearl-center push button mounted on the panel; this gives a neat and handy mounting, as the buzzer and batteries are placed inside the cabinet out of the way.

—GUY SIMMONS, JR.

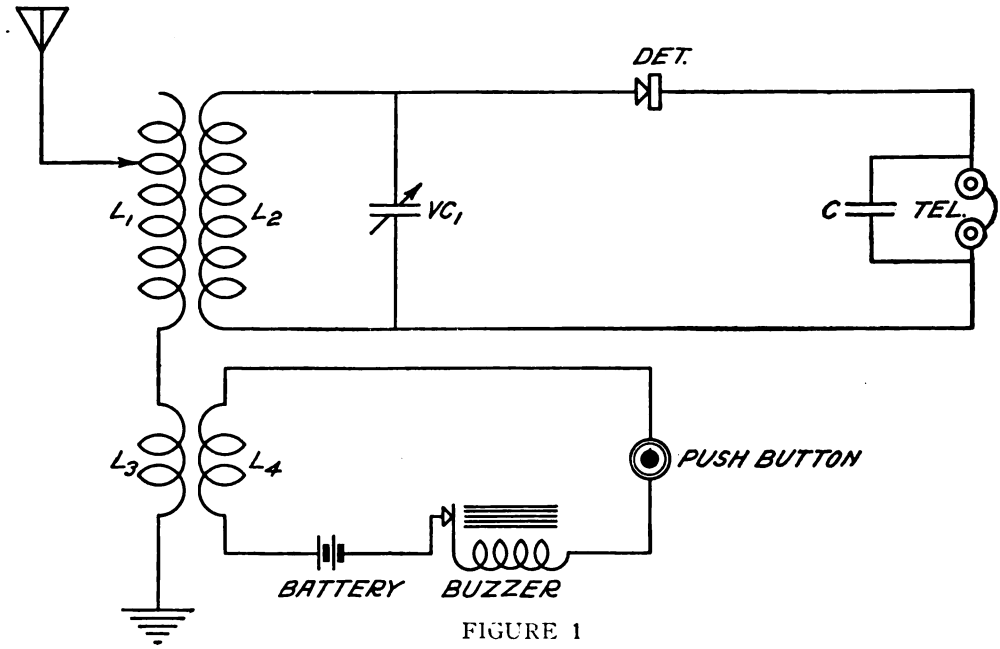

FIGURE 1

How test buzzer should be connected up to the ground circuit of the receiving set by means of two small coils L3 and L4 for the easy adjustment of the crystal detector.

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Do not hook-up one of the accepted standard circuits and, after using it for awhile, with poor or indifferent results, condemn it.

If you have once decided to build a set incorporating a certain circuit, you have probably done so only after reading about someone else's splendid results with the circuit. Therefore, it stands to reason that you must have done something wrong, or neglected to do something which would have been right in building your own version of the circuit. Before condemning the circuit, try out all the connections, investigate all the instruments to see that you have the right capacities, inductances and resistances as specified by an authority, and then think of all the little places that you have skimped and done things in a hurry or substituted some cheap piece of apparatus. After you have rectified all the things that are wrong in the set and after you have really learned to tune it, then is the time to kick. However, it will usually work well and you will be enthusiastic.

But, perhaps you have expected too much from the circuit from the beginning. This all goes to show that a circuit *may be good* but the fans who use poor parts or do careless work in making it think that it is worthless.

* * *

A RHEOSTAT of the wire-wound type should have the separate turns of wire spaced accurately and all the wires should be of the same height where the sliding contact passes over them. This will insure even regulation and prevent the lever catching on the wires as it passes over them.

The wires should be wound on tightly and the whole resistance unit should be fastened onto the rheostat base so that it cannot wobble when the the knob is turned. Be sure when buying a rheostat of this type to make these investigations and buy one that has the correct resistance for the tube you are using.

* * *

IN using insulating tubing on the wires in your receiver be sure to get the best grade of tubing. Do not use a cheap grade that is made of cheesecloth, covered with some kind of gummy rubber compound. Get good, seamless, varnished-cambric tubing that is firm and does not bend out of shape. The cheaper grade will cause you trouble; it will absorb moisture, it will corrode the copper, and it will cause electric leakage. The better grades are expensive but it pays to use them.

* * *

A VERY good way to tell when your filaments are burning at the correct brilliancy is to use a voltmeter which can be shifted so that its terminals can be connected across each tube, one at a time.

The manufacturers of the various tubes give a data sheet with the tubes which states the proper operating voltage for their tubes, and if a voltmeter is used, the rheostat can be adjusted until the reading in the voltmeter is in accordance with the voltage called for on the data sheet.

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THERE are many fans who have in use in their radio receiving sets a loudspeaker of the type that employs a Baldwin phone unit for the reproducer. This unit is sometimes used with a horn, of one description or another, or in a phonograph. When these units are new, and not subjected to signals of too great a strength, the quality is good. But when they have been used for a considerable length of time, and have been forced by signals that are too strong for them, they soon develop rattles and vibrations that are objectionable, to say the least.

Sometimes they begin to chatter; sometimes they squeak on one particular note; sometimes they just give out raspy grunts.

This is almost always due to one of two causes, or both.

The little pin which connects the armature with the center of the mica diaphragm may have become loose. Or, the outer edge of the mica diaphragm may have chipped loose.

Both of these troubles may be eliminated, causing much better operation of the loudspeaker as a whole, and probably restoring all of its original tone quality and volume.

These are the suggestions:

Drop a small quantity of shellac on the little pin joint in the middle of the diaphragm so that it will unite both the metal and the mica and stop vibration. (See Figure 1.)

Cut a narrow ring-disk of blotting paper and place it within the cap so that it laps over the edge of the mica diaphragm. (See Figure 2.)

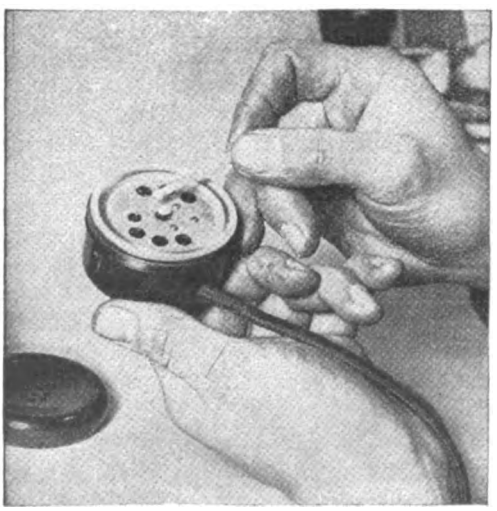
Try these hints and see if they don't make a great difference.

* * *

KEEP the lead-in from your antenna well away from the walls of the building. Do not let it hang right alongside of any brick structure, a fire escape, a drain pipe, metal smoke stack, or any other body of large dimensions. It should swing free by a few feet: the greater distance away the better, up to a distance of about fifteen feet.

* * *

DON'T try to light up the WD-12 vacuum tube above a dull red color.



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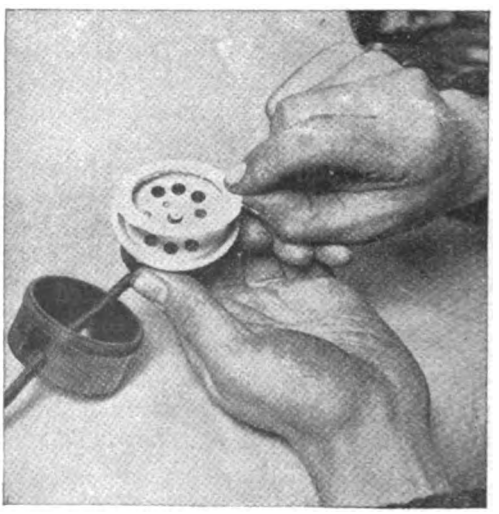

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HOW TO ELIMINATE VIBRATIONS

FIGURE 1: *The chatter in a Baldwin loudspeaker unit may be eliminated by placing a small quantity of shellac about the pin which connects the mica diaphragm to the armature. This prevents vibration.*

FIGURE 2: *A small washer of blotting paper will also stop vibration on the outer edges of the mica diaphragm. It should be placed as shown and the hard-rubber cap screwed down upon it.*

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ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

Ambulances Equipped with Radio

SEVERAL Texas cities are equipping municipal ambulances with a radio equipment. Houston, Dallas and Fort Worth hope within a short time to have municipal broadcasting stations at police headquarters and ambulances while responding to one emergency call may pick up other calls from headquarters and go direct to the scene of the accidents. It is believed that the new method will prove a great time saving device.

* * *

New Station Operated Altogether by Batteries

IN the attempt to prevent interference and poor quality of transmission due to rotating electric machinery in the neighborhood of a transmitter, the new broadcasting station, WTAM, in Cleveland has been equipped entirely with storage-battery power. As the power of the station is 1,000 watts and the necessary voltage is 2,500 volts, hundreds of battery cells are necessary. Moving electric machinery of all kinds has been carefully excluded from the station building and from its immediate neighborhood. The quality of transmission actually attained will have much interest for students of broadcasting technique.

* * *

An Electron that was Worth $40,000

DR. MILLIKAN of the California Institute of Technology has received the Nobel prize in physics for his work in isolating the electron and determining the exact amount of electricity on it. The prize is $40,000.

* * *

Duplex Radiophone for Explorers

A NEW radio outfit for the use of explorers in communicating with civilization, for installation in isolated camps in the desert or jungle and for similar uses has been put on the market in England by the Marconi interests. It consists of two portable sets capable of either receiving or transmitting at either one of two wavelengths, 300 meters or 350 meters. The antenna wire is made in two sections with an insulator between. One section of the wire and one of the wavelengths is used for transmitting, the other for receiving, the receiving part of one set being tuned to the transmitting part of the other. The outfit is made in two powers, 5 watts and 50 watts.

* * *

The Rasp in President Wilson's Voice

ONE of the most interesting features about the broadcasting of ex-President Wilson's speech on Armistice Day was the fact noticed by so many listeners that the President's voice sounded harsh and tired, the voice, one felt, of a sick and disappointed man. Probably nothing that the President or his friends could have done or could have said in print would have aroused so much personal sympathy for him (regardless of the listener's political opinions) as this simple circumstance of our being able to hear him speak. Radio is the only known way of reaching the entire public without losing the personal touch.

* * *

Multiplying Frequencies to Prevent Interference

AT the recent meeting of the British Association for the Advancement of Science Mr. John Scott-Taggart suggested a new way to minimize interference. It consists in multiplying at the receiving station the frequency of the incoming signals by a thousand or more before attempting to read them. For example, two waves of 15,000 and 15,100 meters, respectively, are too close together for distinct reception but if these frequencies are each multiplied by 1,000 (dividing the wavelengths, of course, in the same ratio), the resulting frequencies of 20,000 and 19,868 kilocycles are sufficiently far apart for distinct reception.

* * *

Radio Blamed by the Ignorant for Thunderstorms

THE claim that radio broadcasting is producing bad weather, especially thunder and lightning, seems to have been taken seriously by a large part of the farming population in Europe, with resulting opposition to the growth of the radio industry.

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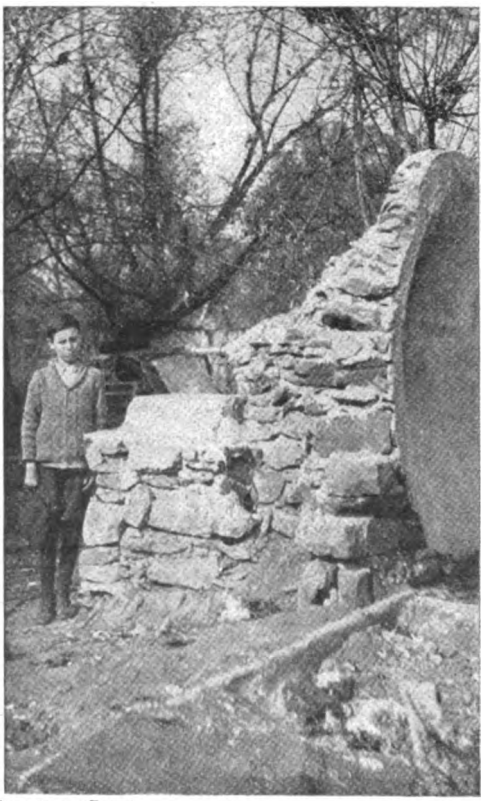
New Broadcasters Overseas

SINCE our last list of the European broadcasting stations (POPULAR RADIO for December, 1923, page 531) four new short-wave stations have come on the ether in Europe with regular programs. In Great Britain, the British Broadcasting Company has added two stations to their previous six. One, at Bornemouth (6BM), transmits at 385 meters; the other, at Aberdeen, Scotland (2BD), is on 495 meters, having the longest wave in use among the British stations. In France, station YN at Lyons has begun a broadcasting service on 470 meters. Music is transmitted at 5:30 A. M., New York time; news and similar material at 6:30 A. M., 10:15 A. M. and 12:15 and 2:30 P. M. In Germany a broadcasting service has been begun by two stations on 290 and 400 meters but transmission is at present irregular in time and does not reach any great distance. There is also a new station at Algiers, Africa (8AY), on 200 meters, but the only material transmitted is the weather bulletin at 8:00 A. M., New York time.



Armstrong Perry

A LOUDSPEAKER FOR THE GARDEN

This unique structure, built of stone and moulded concrete, was made by M. C. Hopkins at his lodge at Waterford, Va. When the reproducing unit at the throat of the horn is connected by two wires to his radio set, the music is broadcast to the whole village.

A New Kind of Broadcaster's Fee

COLUMBIA University is broadcasting a series of ten lectures on the poetry of Robert Browning, and every student who wishes seriously to follow the course is asked to buy a printed outline and syllabus, for which five dollars is charged. In this instance the fee is to cover only the cost of printing but the idea has, perhaps, a wider application. Might not the clients of a broadcasting station be willing to pay a small regular fee like this in order to obtain complete information conducive to better enjoyment of the programs and to greater cultural profit therefrom? Broadcasting must be paid for somehow if the quality of the programs is to be maintained and improved. It is unfortunate, we believe, to allow the advertising value of the service to carry all the cost and thus to control the nature of the material broadcast.

* * *

Police Reserves to be Radio Experts

THE New York Police Department announces that the Reserves attached to its force are to be instructed in radio and will become, it is claimed, the best trained force of radio experts in the world.

* * *

Relay Broadcasting to the Pacific Coast

THE Westinghouse Company has installed a radio relay station at Hastings, Nebraska. Concerts broadcast from Pittsburgh will be picked up at Hastings and relayed automatically to points farther west. It is planned that transmission from Pittsburgh to Hastings will be on about 95 meters and from Hastings west on about 110 meters. Thus comes another step in two developments which POPULAR RADIO has been forecasting for months: *first*, the growth of relay broadcasting and, *second*, the increasing use of the shorter waves.

* * *

German Broadcasting Begins

THE first regular private broadcasting has begun in Germany, a studio in Berlin supplying programs on a 400-meter wave. Other stations are to be installed. Broadcast listeners must secure a license and the regulations surrounding it would be considered, in America, so troublesome as to be almost prohibitive to the growth of the industry. However, the Germans are more accustomed than we are to being told what they must or must not do, so perhaps the regulations will work well enough there.

* * *

The Honor Roll of Broadcasting Stations

THE Bureau of Standards has certified six American broadcasting stations as maintaining a wavelength so exact that their transmission can be used for the calibration of wave meters. They are WGY at Schenectady, KDKA at Pittsburgh, WWJ at Detroit, WCAP at Washington, WOS at Jefferson City, Missouri, and WSB at Atlanta, Georgia. Other approved stations are the navy station at Annapolis and the Radio Corporation stations at Tuckerton, Rocky Point, Coram Hill and Marion.

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Kadel & Herbert

RADIO APPARATUS USED FOR DETECTING SUBMARINE SOUNDS

The U. S. Navy is equipping its battleships and submarines with sensitive sound devices, one of which is pictured above, that enable the operator to determine the proximity of nearby passing motor-propelled vessels. The device amplifies the engine and propeller sounds which are transmitted through the water, and also enables the operator to determine from which direction they originate.

French Government Keeps Tight Rein on Radio

THE expectation that the severity of the governmental control of radio in France would presently be relaxed does not seem to have been realized. New regulations recently promulgated are, if anything, more severe than the old. All receiving sets, even for private use, must be licensed and must pay a tax. If a receiving station is used for public entertainment or any similar purpose it must pay a much larger tax. Broadcasting stations are surrounded with such a maze of regulations as to be, in effect, prohibitory except for a very few stations, mostly under strict government control. American amateurs, inclined at times to protest at the mild and non-restrictive regulations considered necessary by the United States Government, should remember that radio is a hundred times freer in this country than it is anywhere else in the world.

* * *

Will We Have Exclusive Radio News Service for Newspapers.

IT is easier to recall the past than to foresee the future. Indeed the best way to foresee the future is to attempt it in the light of the past. There was a time when newspapers used no telegraph news and when the more conservative editors regarded the new invention of Dr. Morse as a dangerous and unreliable innovation in the business of news gathering. If one wanted real news one sent for an authorized statement to come by messenger or by mail. Why trust it to a wire on which anyone might listen? This is the present attitude of many newspaper men toward radio. But fortunately there are more progressive ones. It is safe to say that in twenty years time, or possibly in five years, radio will be as indispensable in the gathering of news as the wire telegraph is today.

* * *

Edison Says Radio Gives Scientific Training

IN a recent newspaper interview Mr. Thomas A. Edison went on record as to what he believes to be the greatest value of radio to the community. Radio is, he says, "one of the greatest things for young men ever brought out." It is because it gets them interested in science and in scientific literature. It teaches them to think in a scientific way. The boy broadcast listener of today is the experimenting amateur of a few months from now and the scientific research worker or engineer of future years.

* * *

Spiders Spin Trouble for Broadcast Listeners

ANTENNAS, like brains, should not be allowed to grow cobwebby. Several recent reports indicate that fans have had trouble with fading signals because adventurous spiders had stretched their webs across the antenna insulators or from antenna wires to nearby chimneys or other grounded objects. The leakage of the high-frequency impulses over a single stand of spiderweb is large enough, especially in wet weather, to decrease seriously the energy of the received signal.

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Ether Waves Emitted from Furnace Pipes

RADIO waves emitted from transmitting antennas are not the only kind of ether waves that are of household importance. The shorter ether waves of radiant heat are important also—at least to those of us who live in cold countries. A part of the heat given out by radiators and stoves and furnace pipes is discharged merely by contact of the hot metal with the air around it. But another part of the heat is sent out as radiant heat waves emitted by the heated pipe. And just as the nature of an antenna system affects the radio waves emitted from it, so the nature of a furnace pipe affects its emission of heat waves. Polished pipes, for example, emit much less heat in the form of ether waves than do dull or painted pipes. If you want the heat to stay inside a furnace pipe or a steam pipe give it a shiny polished surface. If you want as much heat as possible to come out in the form of ether waves, paint the pipe black.

* * *

Fake Code on the Stage Gets Amateurs' Goat

WE all remember the complaints of the lip readers in the early days of the motion pictures. What the actors really said to each other was quite visible to persons so equipped and it had, too frequently, no relation at all to what was supposed to be said. The same thing has turned up in radio. Several plays recently on the boards in New York have made use of radio messages supposed to be sent in code from a spark transmitter installed on the stage. The stage managers evidently forgot how many amateurs there are nowadays to whom code is as familiar as English. Anyway the supposed operator on the stage merely twiddled the spark a little and the amateurs got disgusted. There were so many protests that when an occasion arose to send a spark message as a part of the setting for a film play in one of the Broadway motion picture theaters, the manager hired a licensed operator to send out in correct code the exact message called for in the action of the play.

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A RADIO SET FOR 60 CENTS

That is the claim made by John P. Buckley, of the Bureau of Standards, for a crystal receiver composed of two small boards wound with primary and secondary coils of No. 27 DCC wire. Connections for the taps and for all other circuits are made in the space between the boards before hooking up the set.

* * *

100,000 *Miles of Carrier-Current Systems in the United States*

THE rapid growth of the carrier-current or "wired-wireless" systems is attested by the recent announcement that the Bell system now includes 20,000 miles of lines equipped for carrier-current telephony and 88,000 miles equipped for telegraphy by the same radio method. The advantage is, of course, that a number of separate messages or conversations can be carried over the same wire without interference. When you talk nowadays over any of the much-used long-distance wires it is a better than even chance that you are talking for at least a part of the distance not by ordinary telephone currents at all but by radio-frequency waves carried over the wires.

* * *

Radio Links Australian Backwoods to Civilization

ONE of the great problems in the less settled parts of Australia has always been the difficulty of communication, as the continent is sprinkled rather generously with desert areas that are all but impassable. The increase of radio stations is rapidly curing this trouble and removing the isolation of even the most distant settlements.

* * *

Does the Telephone Make Us "Left-eared"?

A EUROPEAN scientist reports that people are acquiring better and better hearing in their left ears and worse and worse hearing in their right ears. He ascribes this curious development to the use of the telephone. Most people hold the receiver to the left ear so that the right hand may be free for taking notes. The continued practice of careful attention to the left ear trains that ear to hear more acutely than the other. And it *must* hear acutely, we may remark, if it is to hear anything whatsoever over the average European telephone. If this scientist is right it may be that we will find one of the benefits of radio, especially of DX work, to be an increased acuteness of hearing in *both* ears. Animals hear much more acutely than we do. Men used to hear, in prehistoric times, more acutely than they do now. Perhaps we can get back a part of this lost power.

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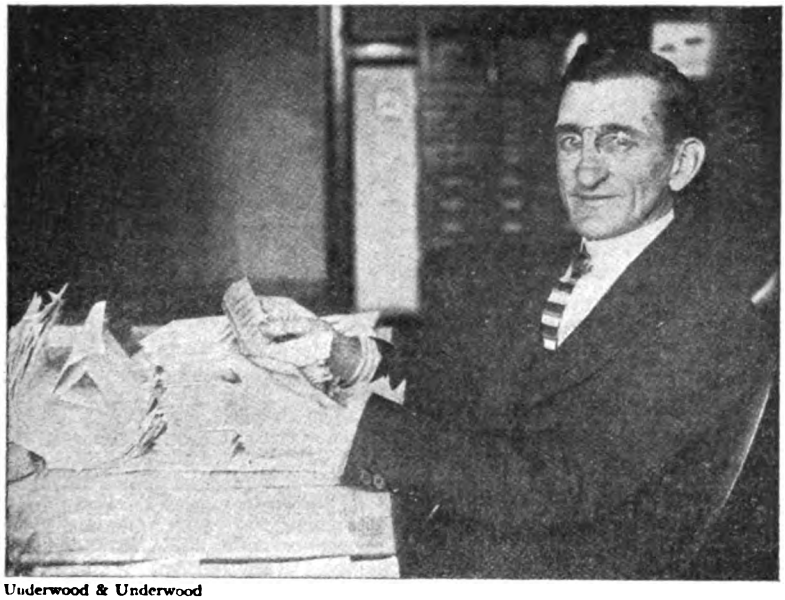

Underwood & Underwood

HE IS COMPILING A "RADIO CENSUS"

W. E. Downey, supervisor of radio in the Department of Commerce, is at work to find out something about radio fans and radio sets in the United States. He has already estimated that 70 percent of the sets have vacuum tubes and 30 percent have crystal detectors.

Who Said Farmers Were Behind the Times?

AGENTS of the United States Department of Agriculture have made a survey of the number of radio receiving sets owned by farmers in 780 counties in farming districts. The results indicate that the number of sets on farms in the United States is probably over 145,000.

* * *

Blow up Your Loop and Listen

A NEW collapsible loop invented in Europe has the wires attached to a rubber tube like a bicycle tire. When you want to use the loop you pump up the tire which extends the loop and makes it operative.

* * *

One Radio Application in Which China Leads

THE use of a radio link in long-distance telephone service, covering a gap in the wire systems, is already in use in China according to Captain R. S. Wood in the New York *World*. A conversation between Hongkong and Pekin goes by land wire to the Hongkong radio station, thence by radio to the Pekin station, and thence by land wire to the instrument of the Pekin subscriber.

* * *

An Absolute Vacuum of Sound

IT is almost as hard to keep every trace of sound out of a room and thus obtain absolute quiet as it is to get all the air out of a vacuum tube and make an absolute vacuum. And every DX hunter knows how disturbing a very small outside noise can be when one is listening with every atom of ear for some very faint sound. The psychological department of Princeton University is adding to its new building a room provided with every known device for keeping out sound. Although built within the larger building, this room of sound-vacuum is an entirely separate structure, having even a foundation of its own so that not the slightest pulse of sound will be conducted into it.

* * *

The Smallest Wire in the World

THE scientists of the Western Electric Company have produced a wire made of a copper nickel alloy and far smaller than any wire previously made anywhere. The wire has a diameter of less than one five-thousandth of an inch. It is practically invisible except under the lens of a microscope. Wire so small as this cannot be drawn in the usual fashion. It has to be eaten away by acid, thus reducing the smallest drawable wire to a still smaller size. The new superfine wires are used in making vacuum thermo-couples for measuring radio-frequency currents.

* * *

A Funeral with Radio Dirge

AT the recent funeral of an assistant fire chief of the Dallas, Texas, fire department, Chopin's funeral march, played by a pianist at the central fire station, was picked up by a radio loudspeaker on a fire truck and the beautiful notes of the march resounded along the procession to the grave. The fire truck bearing the radio apparatus followed the hearse and the funeral march furnished a unique feature of the procession.

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QUESTION: I am starting to build one of the super-heterodyne receivers described in the November and December issues of POPULAR RADIO. Will you please give me the proper connections for the Haynes tuner circuit showing the binding posts?

I would like to have a diagram drawn up in the same style as the two diagrams showing the oscillator and the amplifier units.

I notice that the filament battery is connected with the negative terminal to the negative terminal of the "B" battery. Is this a mistake or does it make much difference which way round the "A" battery is connected? The Haynes-Griffin Company states that the instructions for connecting the "A" battery, as published in the December issue of POPULAR RADIO, are "incorrect." I have tried it both ways and fail to find any difference whatever.

DOUGLAS EHRLICH

ANSWER: The connections for the "A" battery, as published in our December number, are correct; the Haynes-Griffin Company's statement that they are "incorrect" is misleading.

There are, however, two methods of connecting the batteries, and the circuit you require is shown in Figure 1. You will notice that the binding post connections are given in the same manner as in the units described in the November and December issues.

There is no difference, in the operation of the whole set, with the "A" battery connected in one direction or the other, as long as all the units are connected the same way. However, if the "A" battery is connected with the negative terminal to the negative terminal of the "B" battery, the oscillator tube will draw a little more plate current.

To cut down this current we suggest that you connect the batteries as follows:

top post—telephones
next below—telephones
third post—positive "B" battery
fourth post—negative "B" battery

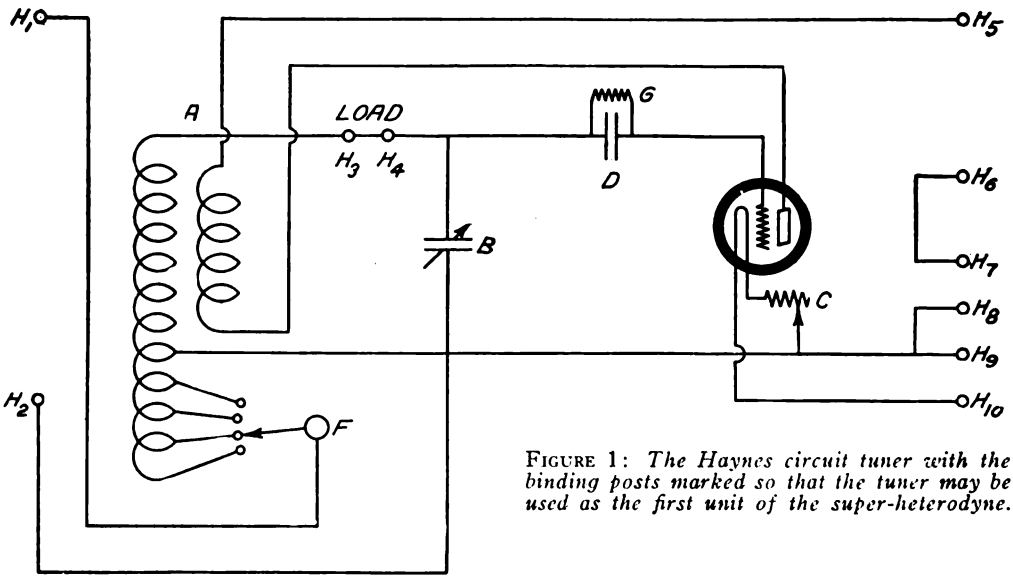

FIGURE 1: *The Haynes circuit tuner with the binding posts marked so that the tuner may be used as the first unit of the super-heterodyne.*

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fifth post—positive "A" battery
bottom post—negative "A" battery.

This will be found to be an improvement over the connections suggested in the December issue in that the "B" batteries will not be called upon to supply quite so much current, and they will last longer.

* * *

QUESTION: Will you please give me a diagram of the Overland circuit? Is this a double-circuit tuner or a modified single-circuit tuner? I have had an argument with some other radio fans who claim it is a double circuit while I claim it is a modified single circuit, so I am sending to get the exact diagram to make sure. We are none of us certain how the circuit works.

RAYMOND PARKER

ANSWER: The circuit you refer to, shown in Figure 2, is a single circuit, with a slight modification in that it has an extra fixed condenser of .001-mfd. capacity included in the ground lead. This same condenser is also included in the plate circuit, as a bypass condenser across the telephones and "B" batteries. The antenna tuning is accomplished by means of a variometer working in conjunction with a variable condenser.

The grid is tuned by the action of the variometer. It is tuned at the same time as the antenna tuning takes place. The circuit is regenerative.

* * *

QUESTION: Does the size of wire used on a coupler or variometer or any kind of inductance matter much? I read in the magazines that most of them in describing a set or instrument give a specific size of wire, although they do not all use the same size. Some instruments call for No. 22 DSC, some for No. 18 SCC and a number of different sizes.

I bought quite a quantity of No. 18 and thought I would use it in all the descriptions, but first, I want to be sure that this would be all right.

A. ANDREW BORNICK

ANSWER: Yes, you should use the size of wire called for in each description. The resistance of the wire figures in the calculations in most regenerative circuits on account of damping, and the size of the wire figures in the calculations for self-inductance, and mutual coupling.

It stands to reason that if you use a smaller diameter wire its resistance will be greater, and this may impair the proper circuit characteristics.

If you use a wire that is thicker than called for and you use, say, thirty turns, the coil or winding will be longer and the coupling will not be as close as specified in the original design. This will affect the efficiency.

Then again you may use DCC instead of SCC or DSC instead of SSC wire. This will also cause fewer turns to the inch and affect the coupling and the efficiency in a similar manner.

It is best to follow the designer's specifications to exactly duplicate his results. The designers tell you what to do: go and do it! The designer tells you what to do, not because he just happened to have some of that size of wire on hand, but because it is the *best* to use for the set described.

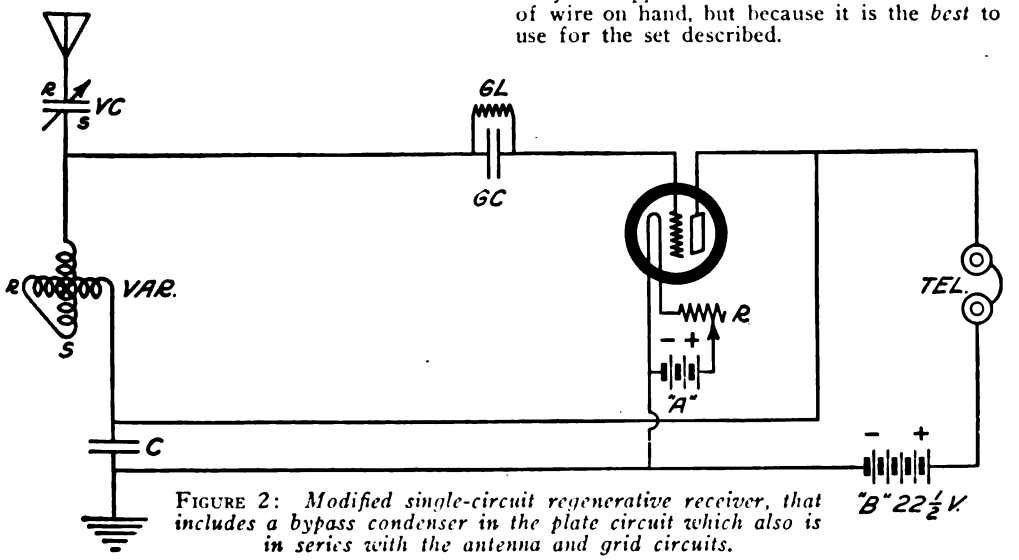

FIGURE 2: *Modified single-circuit regenerative receiver, that includes a bypass condenser in the plate circuit which also is in series with the antenna and grid circuits.*

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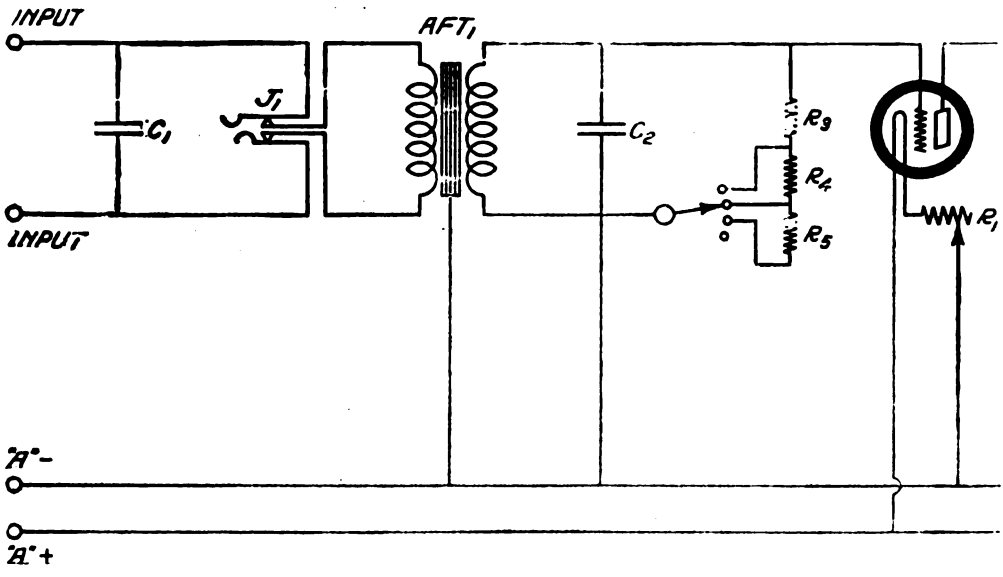

QUESTION: Will you please give me a circuit showing how to add one stage of audio amplification to my detector circuit, and one stage of push-and-pull amplification? I want to use this with my regenerative receiver. Can the circuit you recommend be used with a Western Electric 10-D horn? This is what I want to use if possible. Also include a list of parts. I have two Como transformers as mentioned in your article in the January, 1924, issue of POPULAR RADIO.

DONALD K. BEARD

ANSWER: The circuit you need is shown in Figure 3. This circuit will give good results with the apparatus you want to use with it. You will need the following additional apparatus:

AFT1—audio-frequency amplifying transformer;
AFT2—input push-and-pull transformer;
AFT3—output push-and-pull transformer;
(The above two you have)
J1 and J2—double-circuit jacks;
J3—single-circuit jack;
R1 and R2—filament rheostat, 20 ohms;
R3, R4, and R5—resistances, 50,000 ohms each;
C1—mica fixed condenser, .0005 mfd.;
C2—mica fixed condenser, .00025 mfd.;
switch lever and 4 switch points;
three UV-201-a tubes or three C-301-a tubes;
three tube sockets;
"C" battery, 9 volts;
"B" battery (three 45-volt sections).

You will be able to use the same storage battery as used on your present set. Just connect the two posts marked "A" negative and "A" positive on the diagram to the corresponding terminals of your present battery.

The switch lever connecting to the resistances R3, R4, and R5 constitute a volume control so that you will be able to get just the right amount of signal strength to meet your conditions.

* * *

QUESTION: What is the best method for tuning the grid circuit, a variometer in series with the secondary or a variable condenser shunted across the secondary winding? I mean, which is the best, from a standpoint of selectivity and sensitivity.

HOWARD SAYRE

ANSWER: This is rather a complicated question to answer. From a standpoint of selectivity alone, the condenser-tuned method would probably be preferable. The variable condenser would be connected across the secondary winding and this would give an oscillatory circuit in which the frequency is variable with a change in capacity. The capacity of the condenser would be large in comparison with the tube capacity and the capacity of the operator's hand against the dial. This means that the tuning would not be appreciably affected by body capacity. However, for a particular wavelength range the capacity of the condenser should not be too high, or the signal strength will be lessened and tuning will become extremely critical. On the other hand, with exceptionally low minimum capacity, the capacity in the circuit will approach the value of capacity encountered between the operator's hand and the shaft of the condenser.

From the standpoint of sensitivity, the variometer method would be preferable. This

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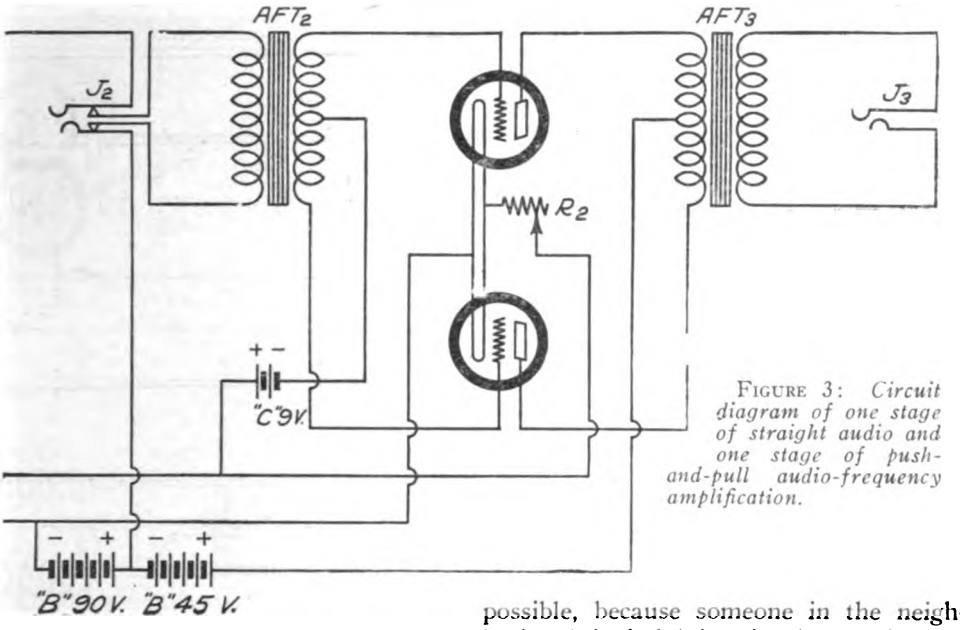

FIGURE 3: *Circuit diagram of one stage of straight audio and one stage of push-and-pull audio-frequency amplification.*

would allow of greater inductance in the secondary circuit with a correspondingly higher turn ratio between the antenna (primary) circuit and the secondary circuit. Theoretically, this would produce a higher grid voltage and if other conditions of resonance are satisfied this is the case, practically. This method, however, is commercially possible only on the lower wavelengths as the series variable inductance would have to be of an enormous range to cover a large wavelength band.

So you see your question takes into account too many considerations (of wavelength, of coupling between circuits, of resonance, turn ratio, cost, practicability, ease of operation, as well as circuit design) for a proper and complete answer in this space.

Considered briefly, from a standpoint of both selectivity and sensitivity, the condenser method fits *most* of the problems *most* economically.

However, some manufacturers stick to one method and some prefer the other, each with seemingly just claims for either of the two methods.

Both of the two systems make use of the same principles of electrical resonance, except that in the one, the capacity is predominant and in the other the inductance is predominant.

* * *

QUESTION: Is there any type of receiver that will eliminate the interference from nearby single-circuit receivers? What would be the best way to solve this troublesome question? It certainly is annoying to try to receive a little DX with a really good receiver and then to find that it is almost impossible, because someone in the neighborhood is indulging in the pastime of twisting the dials of one of these trouble-makers. I think they should be forbidden by law.

A. J. ROBINSON

ANSWER: If you have one of these single-circuit fiends in your vicinity, and he persists in allowing the set to oscillate while trying to tune in distant stations, there is no receiver on earth that will "cut him out."

The best way, at present, is to find out his location and go over and visit him, then when friendly relations are established, invite him over to your house and show him just what his set does to his neighbors' reception.

This should make him repentant and willing to learn to use his set without allowing it to oscillate. Or, you might have even better luck and convince him that he really would get better results in a receiver of the two, three or four-circuit type, or with a circuit employing radio-frequency amplification.

* * *

QUESTION: What value of "C" battery should I use on an amplifier which contains two C-299 vacuum tubes with 90 volts on the plates?

ARTHUR J. BRAUN

ANSWER: A "C" battery potential of 4.5 volts will be correct for use with these tubes. The negative terminals of the batteries should be connected toward the secondaries of the two amplifying transformers and the grids of the tubes. The positive terminals of the batteries should be connected toward the negative leg of the filaments.

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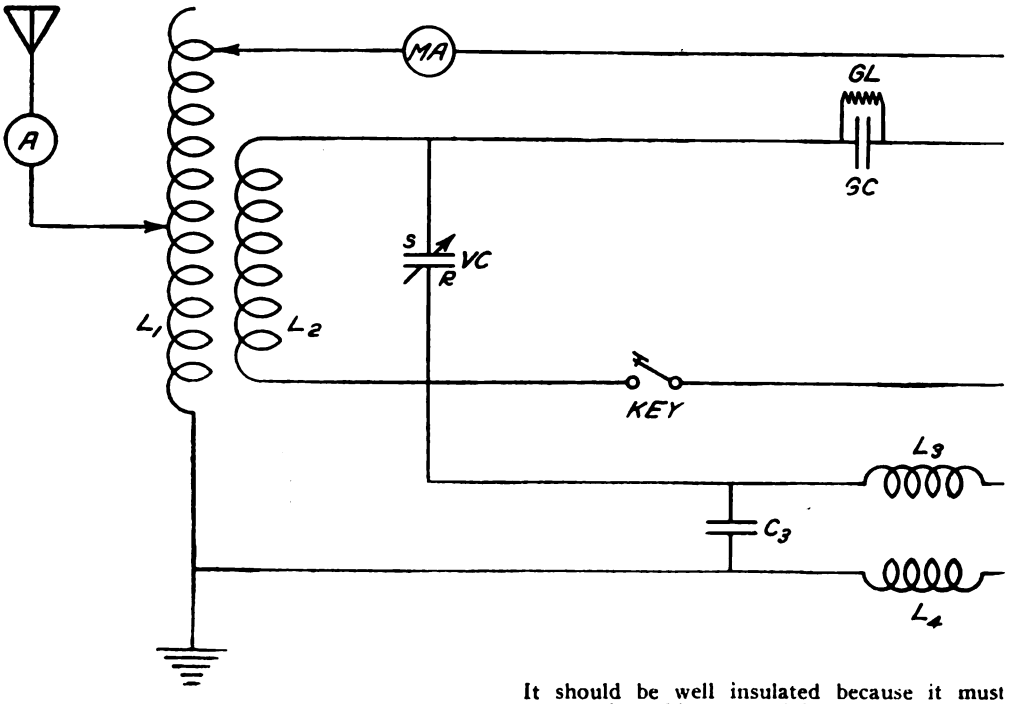

QUESTION: I want to use the circuit known as the "Inverse Tickler" circuit on my 10-watt CW transmitter. I do not know if this is the correct name for the circuit, but it is the one that uses an inductance coil with a smaller coil inside of it connected in the grid circuit of the oscillator tubes. The smaller coil is shunted by a variable condenser, as I understand it. I hope you will be able to identify the circuit I want from my meagre description.

I have made up ten electrolytic rectifier jars to use with a power transformer for the plate supply and would also like to have the dope on a good filter for taking out the hum. What I want to have is a good, pure CW signal without any hum if that is possible with an A.C. supply. Will you give me the necessary data to do this? ARTHUR COLLINS

ANSWER: What you want, we believe, is the British Aircraft circuit which is shown in Figure 4. The larger inductance, L1, may be made by winding about 30 turns of No. 12 bare copper wire on a four-inch tube. The smaller grid-tickler, L2, can be made by winding 20 turns of No. 18 bell wire on a 3½-inch tube inserted in one end of the larger inductance. The variable condenser, VC, is a .0005 mfd. It should be well insulated because it must stand quite a high potential.

Condensers C3, C4, and C5 are 1 mfd. paper condensers that should be capable of withstanding 500 volts, or more, continuously.

Condensers C1 and C2 should be .001 mfd. for by-passing the radio-frequency currents around the filament windings.

The choke coils L3 and L4 are audio-frequency chokes of the order of 1½ henries each. They should be capable of passing about 150 to 200 milliamperes.

The hot-wire ammeter, A, should have a full-scale deflection of 2 amperes.

The milliammeter, MA, should have a full-scale deflection of 250 milliamperes.

The two tubes, VT1 and VT2, may be two radiotrons, UV-202. It will be noticed that the key (for telegraphy) is included in the lead going from the grid circuit to the filament circuit.

The lead plates of the rectifier should all be connected towards the end of the circuit marked L on the diagram and the aluminum plates should be connected to the end marked A. This insures the proper polarity for the plate-voltage supply.

* * *

QUESTION: Should or should not, the coils on receiving sets be painted with moisture-proof paint?

FRANK BURROUGHS

ANSWER: No kind of covering varnish, paint or filler should be used on radio-frequency coils. Such use contributes to both the dielectric losses in the coils and in the value of the distributed capacity of the coils.

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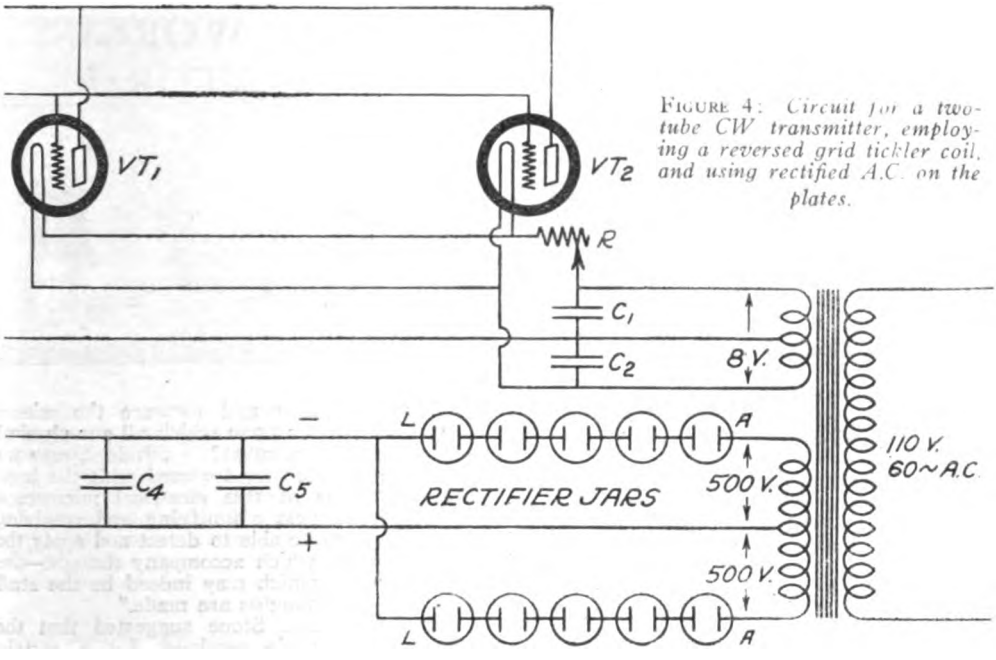

FIGURE 4: *Circuit for a two-tube CW transmitter, employing a reversed grid tickler coil, and using rectified A.C. on the plates.*

QUESTION: Kindly give me a hook-up so that I can use a spark coil with my CW set (one 5-watt tube). At present I am using it with 200 volts of "B" batteries but they die down too fast and I am only able to get about 25 miles. I have a Ford spark coil and I have been told that it will work as an interrupted plate supply if I use a condenser of some kind across the secondary.

A. D. BELMONT

ANSWER: The circuit you require is shown on this page in Figure 4. This is the same circuit you sent in except that the spark coil has been substituted in place of the "B" batteries as a plate-voltage supply. This circuit will give you a signal that sounds like a straight spark-coil transmitter except that it will be sharp in tuning and will enable you to transmit to much greater distances

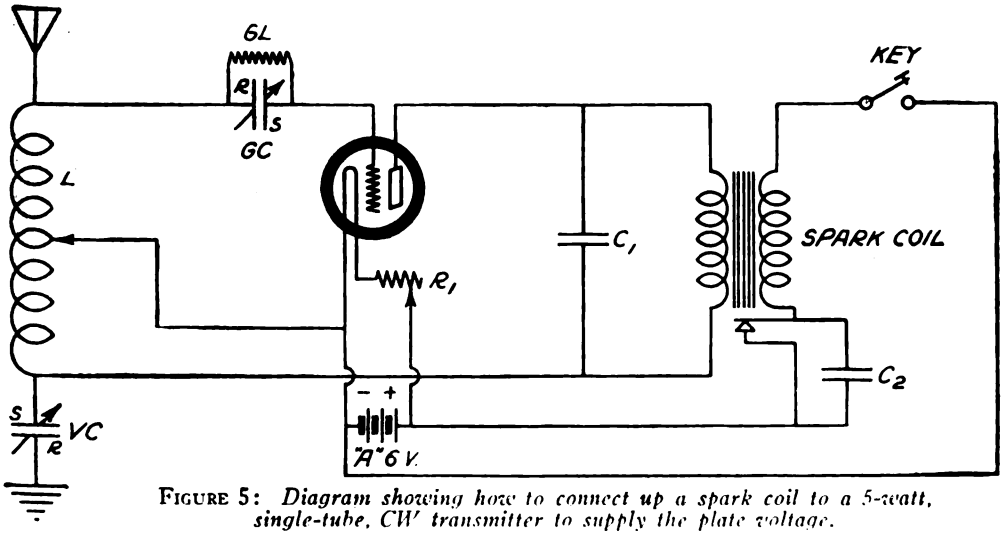

FIGURE 5: *Diagram showing how to connect up a spark coil to a 5-watt, single-tube, CW transmitter to supply the plate voltage.*

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Will Radio Help Solve the Mysteries of Thought?

One of the first American pioneers in radio and one of the most prolific inventors who ever worked in this field is Mr. John Stone Stone, formerly of Boston, now living in San Diego, California. A short time ago, the 1923 medal of the Institute of Radio Engineers was presented to Mr. Stone in recognition of his services to radio science. In his remarks at that time* Mr. Stone made some prophecies which will interest every radio engineer who has even the slightest leanings toward scientific research.

"The art of radio communication," said Mr. Stone, "differs from other electrical arts in that the early growth of these latter has depended almost wholly on empirical developments, while the advances in the art of radio communication, even from its earliest days, have been almost exclusively through the astute application of the principles of the pure sciences. It is this fact that accounts, I believe, for the rapidity with which the art of radio communication reached its advanced achievements.

"For this reason radio communication is under a greater debt to the sciences than is any other of the electrical arts. In looking forward I am not, therefore, so much concerned to see startling advances in the art or profound modifications of its processes as I am to see it repay its debt to science. That this is imminent we may feel reasonably sure, and though I have not the hardihood to attempt to predict the exact nature of its contribution to science, I may, nevertheless, venture to point out that the audion, or three-electrode vacuum-tube amplifier, is a veritable electrical microscope whose power to magnify electrical effects is enormously greater than the visual magnifying power of the corresponding optical instrument. The microscope has made possible bacteriology, with its inestimably important applications to pathology and therapeutics.

"May we not reasonably expect, therefore, that in the near future this prodigious magnifying power of our electrical microscope will be used to detect and measure the minute electrical impulses upon which all our physical functions are predicated? . Indeed, may we not look even further forward with the hope that by means of this electrical microscope of almost limitless magnifying and resolving power we may be able to detect and study the brain currents which accompany thought—the brain currents which may indeed be the stuff of which our thoughts are made."

Continuing, Mr. Stone suggested that the selectivity of radio receivers for a certain wavelength made them analogous to the spectroscope which separates and measures the wavelength of the rays of light. And as the spectroscope has analyzed the stars and created the science of astrophysics, so there is a possibility, Mr. Stone thinks, that a radio-spectroscope would tell us much about the condition of the other worlds off in space. "We also know," he continued, "that the heavens are pouring down on us all manner of electromagnetic waves, and I should be much surprised if they did not bear a message as significant as that brought to us by the light waves from the same source.

"There is nothing very difficult about designing a directive receiver which shall receive electric waves from any particular part of the sky to the exclusion of that from the rest of the vault. And as such a receiver is, by virtue of its selectivity, essentially of the character of a spectroscope, we have within easy reach a means of hearing and understanding whatever of nature's messages are being rained upon us from the sky. If such a directive receiver as that which I have indicated were pointed at the sun during a total eclipse it could scarcely fail to give interesting results."

*As reported in *Radio* (San Francisco), Vol. 5, No. 11, page 10 (November, 1923).

Can Radio Waves Stop Automobiles?

To the repeated reports of mysterious radio waves capable of stopping the engines of French airplanes flying over Germany there is added now an experience described by the editor of a Parisian newspaper, *La Liberté*. According to this observer's report a Parisian engineer,

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whose name and residence are not disclosed, has perfected an apparatus by which he can stop at will, any automobile passing in front of his laboratory.

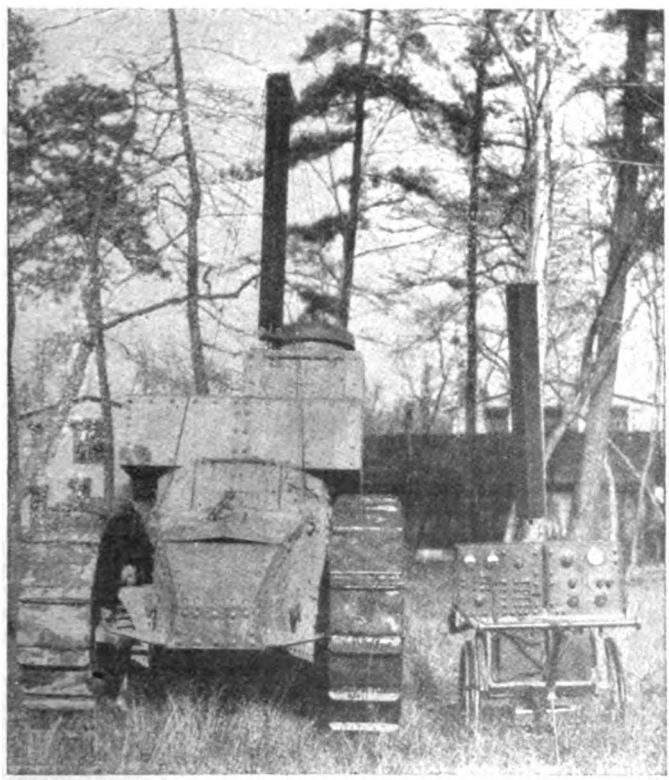
The report is surrounded by too much secrecy as to the names, dates, places and the like to have much weight as a scientific document. We imagine that the engineering world will wait without much excitement until this atmosphere of mystery has been dispelled. It is interesting, however, to inquire whether such an interference with the operation of internal combustion engines is possible at all on the basis of what we now know about radio waves.

There are two ways, theoretically, in which such interference might be accomplished; *first*, by disturbing the current in the ignition circuit, and, *second*, by generating enough heat in the metal parts of the engine to destroy some essential element of it, as for example, a part of the wiring or some delicate adjustment of the carburetor.

The Paris reports mention the automobiles as being able to proceed again at once as soon as the interfering influence was removed. If this is correct there could not have been any interference of the second class, accompanied by actual destruction of parts. The same is true, according to the reports, of the alleged interference with airplanes and automobiles in Germany. We must inquire, therefore, whether it is possible to have interference of the first class, that is a disturbance of the current in the ignition system.

It is very difficult to see how this could be accomplished. It is quite possible, of course, to project radio waves, either by broadcast or in directed beams, and to have them impinge against the engine of an automobile or an airplane. But the voltage thus generated in the metal parts of the engine would be at most a small fraction of a volt, quite comparable in amount with the voltages generated in ordinary radio antennas close to transmitting stations. The superposition of tiny voltages like this on the considerable voltages of the ignition circuits could have no perceptible effect.

Furthermore, the metal parts of the engine, such as the cylinders and the metal cases of the magneto or spark coils, would act as shields and would absorb the major part of the radio energy. All in all, an interfering effect by any known kind of radio waves on engine ignition seems very improbable even if



Tank School, U. S. Army

WAR TANKS NOW HAVE RADIO EARS

At the Tank School at Camp Meade, Maryland, the U. S. Army has devised a radio system for communication between the crews of armored tanks in action and their base station, which may be as much as ten miles away. The transmitting outfit is shown on the small cart at the right.

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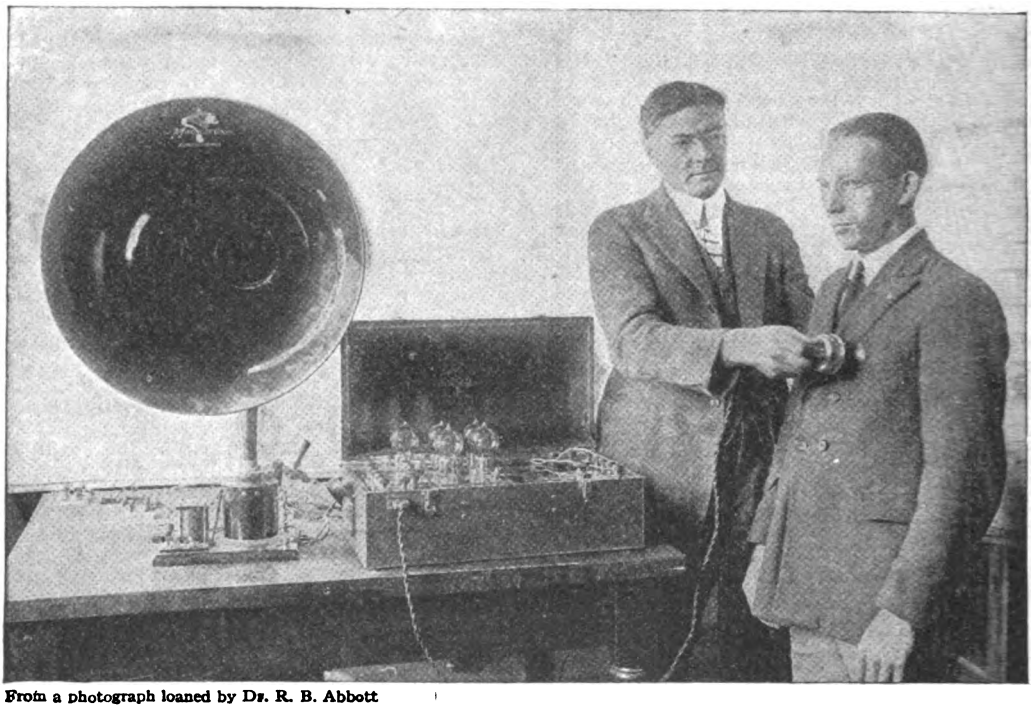

From a photograph loaned by Dr. R. B. Abbott

HEARING YOUR HEART BEAT BY RADIO

This is the first radio stethoscope ever constructed; it was developed by Dr. R. B. Abbott of Purdue University and magnifies the sounds of the beating heart so that they can be heard throughout a large room.

the waves are projected in more or less concentrated beams.

An actual heat effect sufficient to melt fine wires or delicate metal parts would be much more probable. Indeed such effects were obtained by Tesla with his powerful oscillators many years ago. Wires were melted and lamps lit at distances up to many feet away from the transmitting coils.

But such effects would be permanent and do not explain the reported observations either in Germany or in Paris. If these observations are true at all (which is, of course, still an open question) they are probably produced by some entirely new procedure the nature of which it is difficult even to surmise.

Heart Throbs that Shake the House

One of the newest scientific uses of radio is to magnify the sounds of the beating human heart until they seem like blows of a sledge hammer on the roof. A microphone is placed on the chest over the heart and is connected to an amplifier unit of usual character. By properly selecting and tuning the circuits it is possible to secure a magnification of many thousands without important distortion of the sounds.

The orginal object, of course, was medical. Physicians place great dependence on the exact character of the heart sounds in diagnosing disease and it was a limitation of the former methods and instruments that only one person could listen to the sound at once. With the new radio devices any number of persons can listen to exactly the same sound. An instructor, for example, can discuss before his classes the varieties of heart beat and illustrate them simultaneously, all of the students hearing the heart of the same patient at the same instant. The patient need not even be before the class but may be quietly in bed in the hospital, perhaps even miles away.

This method appears to have been used first by Professor R. B. Abbott, of Purdue University, last year.* It has since been applied to medical teaching by Dr. Richard C. Cabot, of Boston † and by Dr. Leo Jacobsohn, of Berlin.‡ Doubtless it will be before long a feature of medical work everywhere.

There is an obvious extension of this method that does not seem to have been tried. This is the *recording* of heart sounds. Since the sounds can now be given any desired intensity it will be possible to make phonograph records of them or to record them in any of the ways now available for audio-frequency oscillations, for

Physical Review, February, 1923.
†*Journal of the American Medical Association*, July 28, 1923.
‡*Die Umschau*, July 14, 1923.

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example, by the phonofilm of Dr. Lee DeForest. A medical school can possess a set of records giving absolutely normal heart sounds, just as it now possesses models of normal human organs or motion pictures of the normal motions of the joints. Furthermore, the heart sounds of a single patient can be recorded from time to time and the progress of disease or recovery thus traced. There is a great field of research and achievement open here for some physician who is also a radio enthusiast.

Static Poses for its Portrait

At the experimental station of the British Radio Research Board at Aldershot, England, a detailed and comprehensive study of radio disturbances of the atmospheric class has been under way for some years. A number of the results were described by Mr. Watson Watt last summer in a brilliant lecture before the Radio Society of Great Britain, the text of which has since been published.* It is one of the most important contributions ever made to the study of this great bane of radio.

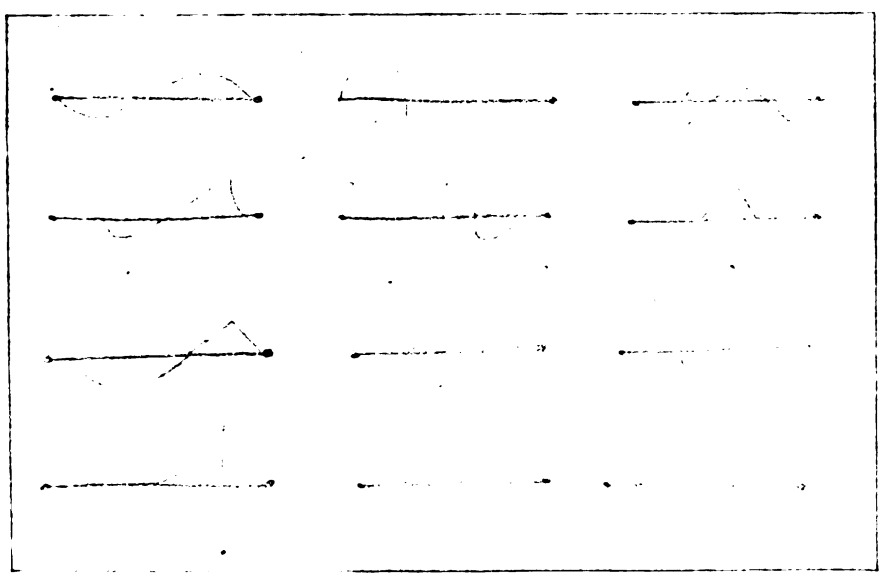
The investigations include two points of especial interest. One is the actual picturing of the form of the static wave. The other is the tracing of some hundreds of individual disturbances (mainly of the "click" variety) to their places of origin on the map of the earth.

The pictures of the static waves are made by a special adaptation of the cathode-ray oscillograph. Photographs can be made but, in the main, the investigators have relied upon pencil drawings made from moment to moment as the wave forms appear on the oscillograph screen. A few of these drawings are reproduced herewith. Perhaps the most interesting feature of them is their variety, and this variety offers much hope to the scientist. The exact wave forms of the clicks and groans that bother us so much are certain to tell us a great deal about their origins when once we have learned to read what these wave forms mean. It is always the *unvariable* things in science that prove the hardest to unravel. If we could detect, for example, any variations in gravitation, that remarkable phenomenon would soon cease to be the mystery it is.

And so the atmospherics, because they differ among themselves, have given us, probably, the key with which to unlock their secrets.

The second feature of Mr. Watson Watt's results, the tracing of static to its geographic lair, was accomplished by training two or more direction finders in separate stations on the same static click and then plotting on the map the lines of direction, in exactly the same way in which a surveyor "triangulates" the position of a distant mountain peak. Out of all the individual clicks recorded, about 1,000 gave simultaneous records at three or more stations. In about 300 of these instances the records indicated a point of origin which was inhabited and from which simultaneous weather infor-

*R. A. Watson Watt, "Observations on Atmospherics." *The Wireless World* (London), Vol. *12*, pages 601-612 (August 1, 1923); discussion, pages 636-637 (August 8, 1923). The full text of this lecture should be read by every serious student of radio science. There is another paper by Watson Watt and E. V. Appleton in the Proc. of the Royal Society (London), Vol. *103A*, pages 84-102 (1923).



Redrawn from *The Wireless World* (London)

WHAT THE WAVES OF STATIC LOOK LIKE

The apparatus used by Mr. Watson Watt for investigating static shows a picture of the wave form of each static impulse on an oscillograph screen. These curves are reproductions of pencil drawings recording some of the typical wave forms.

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mation, as, for example, the occurrence of thunderstorms, could be secured.

In only 45 of these fully traced instances was there a record of actual thunder and lightning, but in 207 instances, or *sixty-nine percent of the cases* rain was falling at the suspected locality. Static seems, then, to be more commonly associated with a mere thunderless rainstorm than with visible electric discharges of the lightning variety. So far as we know this is a new conclusion, and it seems a very important one. It is well known that electric phenomena of the general nature of a silent discharge accompany the fall of rain. The rain drops themselves are known to be electrified. Perhaps the mere formation or evaporation of clouds produces electrical changes with which the radio engineer must reckon if he is to understand transmission and control it fully.

As Mr. Watson Watt himself puts the matter, "The absence of thunder and lightning reports from rainfall areas identified as sources of atmospherics poses a very interesting problem for the meteorologist. Was the electromagnetic wave train constituting the atmospheric radiated from a discharge identical with the visible and audible discharge called lightning? If so, are such discharges taking place above the cloud sheet of all, or nearly all, rainfall areas? And if so, why are the discharges not audible? We may conclude that they are not visible in the daytime because of the opacity of the cloud sheet, but why are they not visible over the edge of the cloud sheet at night? And, if not, what possible discharge can be imagined, capable of radiating energy at a rate comparable with that involved in the propagation of atmospherics?" (A rate which Mr. Watson Watt calculates, for the typical thunderstorm atmospheric, as about that of a 20,000,000-meter-ampere transmitter, or 250 times that of the great St. Assise transmitting station in France.)

These questions remain mysterious but we may feel sure that they will not remain mysterious long. The accurate and continued recording of facts exemplified by Mr. Watson Watt's work is the first step toward an understanding. In the words with which he concluded his lecture before the Radio Society, "What is needed to clear the fog of mystery which seems to have enveloped atmospherics is not a speculation, is not a pound of theory perilously perched upon an ounce of fact, is not an occasional observation isolated in space and time with unspecified circuit constants, but is simply measurement—measurement which need not be elaborate or difficult, but which must be organized, systematic and sustained."

Continuing with some suggestions of what the Brtish radio amateurs could do to help the study of atmospherics, Mr. Watson Watt said, "The recording of the atmospherics occurring immediately after time signals . . . can be done by most amateurs who care to add a simple recording device to their amplifiers. . . . Many of you have frame aerials with which you can make systematic directional observations on atmospherics. Some of you may care to attempt a solution of the most untouched problem of the inclination to the vertical of the wave front in atmospherics. Some might prefer to try forecasting local weather by observation of the types of atmospherics preceding different meteorological events."

These suggestions are just as live for the American amateur as for his British colleague. Why not attempt some of these really valuable scientific inquiries? Remember that Benjamin Franklin got his name in all the text-books with the simple apparatus of a key and a kite.

Will Radio Help Bring a New "Age of Aluminum"?

THERE is evident in modern industry, especially in the radio industry, an event which future historians will probably regard as a turning point in human history. It is the passage of human society from the Age of Iron, now some 3,000 years old, into the Age of newer metals—of Tungsten, perhaps, or of Aluminum.

Historians have been accustomed to divide history in accordance with the material that men used for tools. First was the Age of Stone, then the Ages of Copper and of Bronze, finally the Age of Iron. But this Iron Age was not to be, it is evident, the final one. Already it is passing into an age that will depend on other metals, probably, in the main, on aluminum.

A dozen or so of these newer metals are already indispensable to radio. Tungsten, for example, for tube filaments; selenium for light-converting devices; molybdenum for the plates of power tubes; thorium, sodium, tantalum, tellurium and several others.

Aluminum, the most promising of the new metals as a structural material, has not found as yet much use in radio but there are indications that it will. For example, antenna towers and masts made of the new aluminum alloys devised for airship construction would be far lighter than steel construction and far more durable than wood. They have been suggested and no doubt will be tried out. Aluminum panels for receiving sets, equipped, of course, with insulating bushings for the shafts of instruments, would have many advantages of permanence, lightness and automatic shielding. We have seen one fine set recently in which the panels were supported by light-weight braces of an aluminum alloy. It is not at all beyond the bounds of possibility that the alloys of aluminum, which are numerous and widely varied in their properties, will provide our grandchildren not only with airships and antenna towers but with houses and tools and furniture and many other things.

Do Clouds of Ionized Air Affect the Radio Compass?

THE appearance of a special report of the British Radio Research Board on systems of direction finding by radio, calls attention to

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the fact that the radio compass, in spite of its extraordinary practical value, has not yet reached a stage of perfect dependability. American readers will recall the recent destroyer wreck on the Pacific Coast, when the radio bearings were so much distrusted by the officer in charge that they were altogether ignored. In this instance the bearings happened, it seems, to be right, but it must be admitted, even by the most enthusiastic defenders of radio, that bearings obtained by radio compass are wrong often enough to furnish a certain justification for ignoring them when they conflict with other positional data.

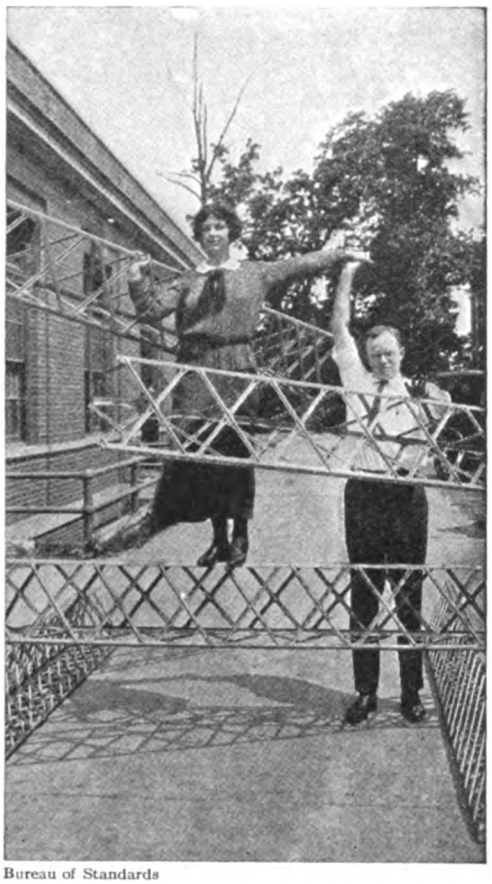
The systems tested and described in the British report* include the single revolving coil (frame antenna), which gives direction by the position of the coil for largest signal strength, and two other systems, the Robinson and the Bellini-Tosi, which make use of two receiving coils fixed at different angles and which determine direction by the relative strength of the signal in the two coils. The theory and operation are discussed. There is no discussion of the several other systems that have been proposed and tried, such, for example, as the systems employing coils of special shape adapted to pick up signals from a single direction only.

In our opinion, however, the chief difficulty with the radio compass lies not in the coils nor in any other feature of the apparatus. It lies in the ether. For some reason, as was pointed out by Dr. Fessenden in POPULAR RADIO for November, the waves do not always go outward from the radio stations on shore in straight lines. When a station is really southwest from a ship at sea the ship may receive the radio waves apparently from the south or the east or even from the southeast or northeast, an error of a full ninety degrees in the compass bearing.

The cause is probably, as Dr. Fessenden suggested, the bending of the waves by interposed clouds of ionized air or by other obstacles. The use of several simultaneous waves of widely different wavelength will help. These waves are bent, Dr. Fessenden finds, to different degrees, thus permitting, by comparison between them, a good guess as to the real direction of the sending station.

But this is at best a partial solution of the problem. What the navigators need is an apparatus that will give them automatically, without calculations or guessing, the exact direction of a sending station on shore. Perhaps some way can be found to overcome the tendency of waves to bend or possibly Dr. Fessenden or someone else can devise a receiving instrument which will make, automatically, the comparisons and calculations necessary to deduce the true direction from signals received at several different wavelengths, much as the tide machine makes, automatically, the calculations necessary to predict the times of the tides. The problem is one not beyond the reach of amateur experimenters and there are few devices that would be of more value to world transportation than a fully dependable radio compass.

* "A Discussion of the Practical Systems of Direction Finding by Radio," by R. S. Smith-Rose and R. H. Barfield. Special report No. 1 of the Radio Research Board. Published by H. M. Stationery Office, London. Price 9 pence.



Bureau of Standards

HOLDING A METAL GIRDER ON ONE THUMB

These girders of an aluminum alloy designed for use in airships are so light that a girder capable of supporting many pounds can be suspended comfortably on a man's thumb.

Are Ether Waves Composed of Minute Particles?

MOST of the characteristics of ether waves have been discovered and investigated with one particular kind of them, the kind we call light. This has happened, of course, because the light waves chance to be visible while the other kinds, like radio waves and heat waves and X rays and the others are not visible. To detect and examine these other kinds of waves we need various kinds of apparatus, photographic plates for the X rays, coherers

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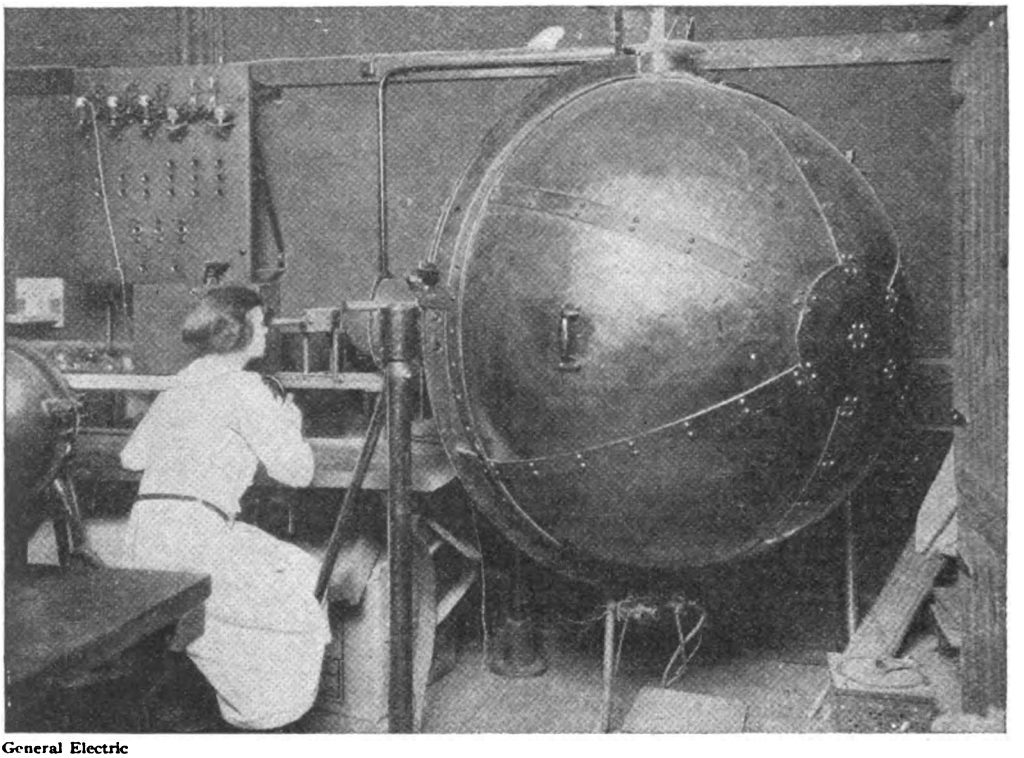

General Electric

A MACHINE THAT CATCHES ALL THE ETHER WAVES OF LIGHT

This is a spherical photometer used to measure the light rays that are sent out by an incandescent lamp. The round globe catches the rays sent out in all directions so that their total can be measured at the same instant. Similar machines have been suggested for short radio waves, but they have never been built.

or other detectors for the radio waves, and so on.

And among the ether-wave properties that have been discovered with light waves there has been for some years one that is most mysterious. This is the phenomenon of the quantum. It is, in effect, the fact that light is sent out and received in small separate particles rather than in a continuous wave. We do not know for sure that this same thing happens with radio waves, but presumably it does. All ether waves, we suspect, are really received in small chunks or squirts, like the drops of a rainstorm as contrasted with a really continuous sheet of falling water.

How can one imagine something that is a *wave* and which nevertheless appears to be in *particles?* The answer is that one cannot. That has been, and to some extent still is, one of the great mysteries of modern physics. The facts are contradictory to each other. Light is a wave. Many facts prove this. But light also seems to be in particles. An equally large number of facts prove this. Many physicists have spent sleepless nights over this mystery in the last ten years.

The present state of scientific opinion on this up-to-the-minute question has just been summarized by Sir Oliver Lodge in a brilliant series of articles in the London engineering journal, *Beama.** Sir Oliver suggests a probable cause for the mystery. It lies, he says, in the structure of the atoms of matter.

Whenever we perceive light we do so, of course, through the help of matter. Our eye consists of matter arranged in atoms, as every other material thing is arranged. Without atoms we have nothing, at least nothing material. Light is produced, also, by atoms. The filament of an electric lamp shines because the atoms of matter in it are hot and give out light. A gas flame shines because the atoms in it are light givers. All other ether waves are produced, similarly, by matter. A radio wave goes out through space, not from nothing, but from the electrically charged wires (composed of matter) of the antenna.

Now it is probable, says Sir Oliver, that the property of light and other ether waves of coming in small chunks, each one of which is called a quantum, is a property not of the ether wave itself but of the atoms of matter.

* "The Quantum and the Structure of the Atom and its Radiation," by Sir Oliver Lodge, *Beama*, Vol. 13, pages 11-19, 80-88, 148-157, 211-220 (July, August, September and October, 1923).

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The ether wave may be smooth and continuous, as we naturally think of it. But it affects atoms or is produced by atoms, only in separate pulses.

Sir Oliver uses an excellent analogy. The atoms, he says, are like banks that pay out or receive coined money. The money is in small equal chunks, like pennies. The bank pays out or accepts so many pennies. It cannot pay out nor will it accept any fractional part of a penny. You cannot pour into a bank a continuous small stream of copper and have it accepted, nor will the bank issue coinage in a continuous metallic stream. It is either a penny or nothing.

Just so with the atom. If ether waves are to have any relations at all with the atomic banks it must be in certain small chunks of the wave, in a kind of ethereal penny. It is either one of these ether-pennies (one quantum) which the atom emits or accepts, or else it is nothing at all.

This peculiar property of atoms, responsible for this long-standing mystery of the quantum, is related, Sir Oliver thinks, to the fact that atoms consist of electrons that revolve around a central nucleus much as the planets of our solar system revolve around the sun. So long as the electrons stay each one in its own proper orbit no ether waves are given out or received. But the electrons can jump sometimes from one orbit to another, as though our earth suddenly jumped closer in to the sun and occupied thereafter the orbit of the planet Venus. When this happens a sudden pulse of ether waves, usually light or X rays, is sent out from the atom. In a flame the light is due to billions on billions of such electrons jumping busily from one atomic orbit to another. This is why the light seems, if we study it closely enough, to be in separate particles or squirts. It *is* in squirts; one squirt for each little electron jump.

This theory that there are a number of separate orbits for electrons inside of atoms and that the production of light or X rays or any other kind of ether waves is due, usually, to jumps of the electrons from orbit to orbit, is the famous atomic theory of the great Danish physicist Niels Bohr.* It is the latest word of science about the mysterious things that go on inside the atom.

Just how these new ideas of the atom and of the quantum will affect our theories of the longer ether waves used in radio is not yet apparent. That the radio theories will be affected in some fashion is beyond doubt. Radio waves are produced, of course, by the movement of electrons; by the surges of electric charge back and forth into the antenna. The quantum relations probably apply to these longer waves just as definitely as they apply to the shorter waves of light. Future radio theories must take them into account, and radio engineers who desire to inform themselves of scientific progress in this field will find no better introduction to it than these authoritative and clearly written articles of Sir Oliver Lodge.

*This theory will be described in an early number of POPULAR RADIO.

Measuring Radio Waves with a Yardstick

THIS has been accomplished, quite literally, at the United States Bureau of Standards. Dr. F. W. Dunmore and Mr. F. H. Engel have devised an apparatus by which radio waves are measured off in feet and inches (or in meters) directly, just as you would measure rope or wire. This was done as a part of a method developed for the calibration of standard wavemeters for the use of the Bureau's radio inspectors.*

Such wavemeters have to be checked, of course, by comparing them with some fixed standard. It is not enough merely to compare them with another meter. So Dr. Dunmore and Mr. Engel set up a wave generator consisting of a single vacuum tube and inductances and capacities designed to generate very short waves, 9 to 16 meters long. These waves were communicated to two parallel copper wires strung between supports so that a standing wave was set up in these wires. The next problem was to measure the length in meters of this standing wave.

The device for this was merely a delicate thermo-galvanometer hung on the two wires, one terminal on each wire. This galvanometer could be slid along the pair of wires like the carrier baskets sometimes used in department stores. A standing wave having been set up, the galvanometer was slid along the wires until it showed a maximum current passing through it, that is between the two wires. This place was marked. Then the galvanometer was slid along again until another place of maximum current was reached. The distance between these two places of maximum current was exactly the length of a half-wave. Putting a meter-stick on this distance gave a direct measure of the wave in meters.

These standing waves were too short, of course, to be used in direct calibration of radio wavemeters. This was accomplished by comparing the harmonics of a third circuit with the short standing waves and then using the circuit so measured to standardize the wavemeters.

By a succession of such comparisons, the wavelength used being increased step by step, it is possible to establish a definite and absolute standard of length for waves of any desired frequency.

The investigation marks, not only a substantial increase in the accuracy in wavelength measurements but a new step in the control and utilization of the very short waves. Ten years ago any wave under two or three thousand meters was considered "short," too short to be of any practical use. Nowadays these waves are the most used of all and the "short" waves are those under a hundred meters. Perhaps a decade from now we will be broadcasting at 10 or 15 meters and talking about "short" waves an inch or two long.

*Dunmore and Engel, "A Method of Measuring Very Short Radio Wavelengths and Their Use in Frequency Standardization," *Proc. Inst. Radio Engineers*, Vol. 11, pages 467-477, (October, 1923).

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A limited number of questions of general scientific interest will be answered each month in this department. Readers are invited to send in questions that have puzzled them—but the selection of questions for answer cannot be guaranteed nor can questions outside the radio field be answered by mail.

Will it do any harm to erect an antenna close to a lightning rod?

No. A lightning rod is merely a grounded wire. So long as the antenna wires do not touch it and are kept a couple of feet away from it neither the lightning rod nor the antenna will interfere with the other.

Can good "radio weather" be predicted by a barometer?

So far as now known it cannot. The barometer measures the pressure of the air and nothing else. It is true that the air pressure gives some indication of the state of the weather, especially if you have for comparison the barometer readings at many places in different parts of the country, as the Weather Bureau has when it prepares its weather forecasts. But a single barometer reading means little, even about such things as rain or temperature and, inasmuch as the effects of weather on radio transmission are still mysterious and mostly unknown, a barometer reading at your house will be practically useless in predicting the possibility or impossibility of DX work.

Why is it necessary to solder the connections of a radio set? Electricity passes easily, does it not, between two wires if they merely touch one another?

THE electricity passes easily enough if the wires really touch but unless they are soldered together they usually do not touch; they merely seem to. In between the surfaces of two wires that are wrapped together there exists, really, a tiny film of air. This air film is too thin for you to see it, but it is thick enough that feeble electric currents cannot cross it. Soldering the wires together removes this air film and replaces it with a film of solder, which is an electric conductor. Then even the feeblest currents can pass from wire to wire without difficulty.

Why does oilcloth, used to line a panel or elsewhere around a set, make the set work less satisfactorily?

BECAUSE most varieties of oilcloth are really conductors of electricity. They contain metallic compounds like zinc-white or white-lead. These compounds are conductors. The oilcloth has a considerable capacity, just as a sheet of tinfoil has. It acts also as a channel for current leakage. It is even possible to make grid-leaks out of oilcloth.

Why is a vacuum-tube worthless when the point is broken off?

BECAUSE air gets in through the tiny hole thus made and destroys the vacuum in the tube. With air in the tube the filament burns up instantly as soon as you heat it.

What is a gravity cell?

IT is a kind of electric battery in which the two different liquids necessary to operate the battery are kept apart by a difference in density or "gravity." For example, the electric batteries formerly used a great deal in telegraph work, had a plate of copper at the bottom of a glass jar and a plate of zinc at the top. The two solutions were copper sulphate at the bottom of the jar and zinc sulphate at the top. The zinc solution, being lighter, floated on the copper one like oil on water.

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What makes the bubbles of gas when two wires are dipped into water and an electric current is passed between them?

THE electric current decomposes the water into the chemical elements of which it is composed. These are two gases, oxygen and hydrogen. The oxygen collects at one of the wires, the hydrogen at the other. These gases make the bubbles that you see.

Why does the X-ray machine used by dentists interfere so much with nearby radio sets? Is it possible to screen off the X rays in some way?

IT is not the X rays that do the damage. It is the radio waves sent out by the machine. An X-ray apparatus is operated by means of high-voltage electric current. Whenever this current is turned on or off the whole apparatus acts exactly as though it were a radio transmitter of the spark variety and sends out a pulse of ether waves. The problem of cutting out interference is exactly the same as the problem of preventing interference from high-power spark stations or from electric substations. It is a very difficult problem and has not yet been solved completely.

What material is the most perfect insulator?

THE answer to this question depends upon what you want to use the insulator for. The voltage of the current, the temperature, the degree of moisture that is about and many other things, affect the perfection of insulating materials. Some idea of the value of different insulators can be obtained from their dielectric constants. For a definition and discussion of the dielectric constant it is necessary to consult a treatise on electricity. Here are some comparative values of the constant. This does not, however, determine all the properties of an insulator.

Pitch	*1 to 2*
Vaseline	*2.2*
Paraffin	*2 to 3*
Ebonite	*3.0*
Shellac	*3 to 4*
Sulphur	*4.0*
Porcelain	*4 to 7*
Rock Salt	*5.6*
Mica	*6 to 7*
Glass	*6 to 10*
Pure Water	*70 to 80*
Pure Ice	*93*

Why is it necessary to use distilled water instead of ordinary water in making up the acid for a storage battery?

BECAUSE ordinary water is not quite pure. There are always small amounts of various chemicals dissolved in it, as you can prove by evaporating some of it from a clean dish. A little crust or scum of solid material will be left behind in the dish. These chemicals in the ordinary water may combine with some of the materials on the plates of the storage battery and damage it for use. Distilled water is pure and does not contain any of these possibly dangerous chemicals.

I have seen mentions of the "absolute ampere" and of the "international ampere." Are there two kinds of amperes?

THERE are not exactly two kinds of amperes but there are two ways of defining this electric unit. They are almost alike, but not exactly so. The absolute ampere is based on the fundamental units of electricity used in precise scientific work. It is defined as the current which will deposit in one second, under standard conditions, .00111827 gram of silver. The international ampere is the one defined by the last international conference on electrical units. It will deposit, under the same conditions mentioned, .00111800 gram of silver. For practical purposes the difference between the two values of the ampere is negligible.

Why do some of the books say that electric current flows from the positive to the negative pole, while other books say that the electrons which compose the current flow from negative to positive?

THIS is a puzzling confusion which is due, altogether, to the fact that when we first began to use electricity we did not know what it really was. The electricians of the time of Benjamin Franklin knew that there was such a thing as electric current but they did not know which way it flowed. So they *assumed*, merely for convenience, that it flowed from positive to negative and this assumption got into all the books and all the mathematical formulas. Later on, we discovered that this assumption happened to be wrong. The electricity, that is the stream of electrons, really flows from negative to positive. It would be better if all the electrical formulas recognized this but it is so much of a job to change them all that most electricians continue to use the old ones.

I am told that the dust from coal smoke settling on my antenna will decrease the strength of the signals I receive. Is this true?

YES. The dust usually contains more or less iron and carbon and other substances which conduct electricity. If there is a coating of soot on the antenna it will cover the insulators as well as the wires themselves and a part of the received energy will leak away through this soot layer, just as the energy on a grid leaks away slowly through a pencil mark used as a grid-leak.

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If you are getting good results with your receiving set, tell your fellow-readers of POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

WHAT ONE TUBE CAN DO

WITH the single-tube receiver described in the April number of POPULAR RADIO, H. P. Krag of Kensal, N. D., has heard as many as eleven stations in one night in summer weather. He uses a peanut tube in the two-circuit hook-up described.

His record for one evening is the followir , list: WLW, Cincinnati, O.; WJAZ, Chicago, Ill.; WOS, Jefferson City, Mo.; WBAH, Minneapolis, Minn.; WHAS, Louisville, Ky.; WBAP, Fort Worth, Texas; WDAF, Kansas City, Mo.; CFCN, Calgary, Can.; WLAG, Minneapolis, Minn.; WOAW, Omaha, Nebr., and WOC, Davenport, Ia.

* * *

WHAT HIS CRYSTAL DID

A VARIOCOUPLER and two variable condensers in a crystal set made entirely at home by C. E. Van Kirk of St. Paul, Minn., are tuning to Pittsburgh, Pa., Davenport, Ia., and a number of other stations. His record reception is from KSD, WHB, WCX, WWJ and KDKA. The condensers, made at home from eleven plates of brass are closely spaced to give them a capacity of almost .0005 mfds. The coupler is wound with number 22 enameled wire on a shellacked tube about 3¼ inches in diameter for the primary and a spherical wooden ball for the secondary. The clearance between the two is about 1/16 of an inch. The primary of the coupler has 100 turns, tapped at every tenth turn, and the secondary has 60 turns. One condenser is used across the secondary and the other in the antenna circuit.

Van Kirk has been told, as holders of crystal records are usually told, that he is receiving re-radiation from a near-by tube set, but he states that he can pick up the distant stations most any night and hold them for as long as a half hour.

REFLEX ELIMINATES STATIC

ORAN DOGGERT of Catlin, Ill., says he eliminates static entirely through careful tuning of his single-tube reflex receiver, which uses dry cells.

"My record is CWA, Montevideo, Uruguay," he claims. KYJ of Los Angeles [illegible] KQY of Portland, Ore., he receives on an average of twice a week. He uses an antenna of 130 feet, 20 feet high. He has made two loop antennas with wire taken from a Ford spark coil and has picked up WLW, Cincinnati, O., and WGY, Schenectady, N. Y. Signals are somewhat louder, he finds, when he connects both outside antenna and loop to his set.

Some of the stations he has heard are WSY, Birmingham, Ala.; WFI, Philadelphia, Pa.; WFAA, Dallas, Tex.; PWX, Havana, Cuba, and CHYC, Ottawa, Canada.

* * *

THE SINGLE-CIRCUIT AGAIN

WHILE the single-circuit set is seldom selective and although it is condemned because it sometimes sends its squeaks into a neighbor's receiver, it is still a leader as a distance getter. Dr. W. W. Lewis of Marvell, Ark., who constructed one from a diagram on page 233 of POPULAR RADIO for March, frequently hears Los Angeles and Denver with one dry-cell tube.

His antenna is a long one as antennas go for single-circuit sets, a stretch of 100 feet with a lead-in of 90 feet. He uses one variable condenser of 43 plates; a variocoupler of 60 turns, tapped every five turns, with 40 turns on the rotor, which serves as a tickler coil; the ordinary grid leak and condenser and a pair of 2,200-ohm phones.

With careful tuning he also heard Memphis, Tenn., Davenport, Ia., Kansas City, Mo., Atlanta, Ga., Ft. Worth, Tex., and a long list of others.

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Now for the hook-up

THE radio set builder's eyes shine with pride as he inspects his drilled Celoron panel. He has done a good job. The finely finished Celoron panel reflects his good workmanship. He is ready to mount his instruments and make the final connections.

A Celoron panel insures good looks to the radio set. Celoron panels are finished in black, oak and mahogany. Each Celoron panel is wrapped in a dust-proof glassine envelope to protect its lustrous surface. Grit cannot scratch it. Hands cannot fingerprint it. You are the *first* to unwrap it.

Celoron, a bakelite product, has high dielectric strength. It is approved by the U. S. Navy and the U. S. Signal Corps.

Special-sized Celoron panels are cut to order from sheet Celoron. Standard Celoron panels come cut and trimmed, ready to use, in these sizes:

1—6 x 7 x 1/8	5— 7 x 18 x 3/16
2—7 x 9 x 1/8	6— 7 x 21 x 3/16
3—7 x 12 x 1/8	7— 7 x 24 x 3/16
4—7 x 14 x 3/16	8—12 x 18 x 3/16
	9—7 x 26 x 3/16

Write for our interesting booklet, "*Getting the Right Hook-Up.*" Sent *free* upon request.

To radio dealers: Send for special dealer price list showing standard assortments

Diamond State Fibre Company

BRIDGEPORT (near Philadelphia) **PENNSYLVANIA**

Branches in Principal Cities
Toronto, Canada — London, England

CONDENSITE CELORON
STANDARD RADIO PANEL

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"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"

Eveready "Three"

4½ volts, three distinct uses. Length, 4 in.; width, 1⅜ in.; height, 3 in.; weight, 14 oz. At all reliable radio dealers.

This "C" Battery is a Wonder Worker

Digitized by Google

"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"

For Quality Reproduction

YOU can make the loud speaker respond with a new fullness and naturalness of tone. You can save money by adding months to the life of your "B" Batteries. These things you can do by using the new Eveready "Three" as a "C" Battery.

You already have an "A" Battery for the filament and a "B" Battery for the plate. A "C" Battery is connected to the third element of your vacuum tube, the grid, affording a control that is marvelous in action on audio frequency amplifiers.

As a "C" Battery the Eveready "Three" prevents distortion and excessive flow of current from the "B" Battery, lengthening its life. It is a wonder worker that saves its small cost many times over. Connect it in your audio frequency amplifier and note the difference. Full directions on the label and in "How to Get the Most Out of Your 'B' Battery," a booklet on "B" and "C" Batteries, sent free on request.

This triple-use battery can also be used as an "A" Battery in portable sets. Light and full of pep. Its third use is as a "B" Battery booster.

Use the Eveready "Three"—a tested product of the world's leading electro-chemical battery laboratory. It serves more radio uses and effects more economies than any radio battery heretofore developed.

If you have any battery problem, Radio Battery Information Headquarters will solve it for you. Write G. C. Furness, Manager, Radio Division, National Carbon Company, Inc., 128 Thompson Ave., Long Island City, New York.

NATIONAL CARBON COMPANY, INC.
Headquarters for Radio Battery Information
New York San Francisco
CANADIAN NATIONAL CARBON CO., Limited. *Factory and Offices:* Toronto, Ontario

EVEREADY
Radio Batteries
—they last longer

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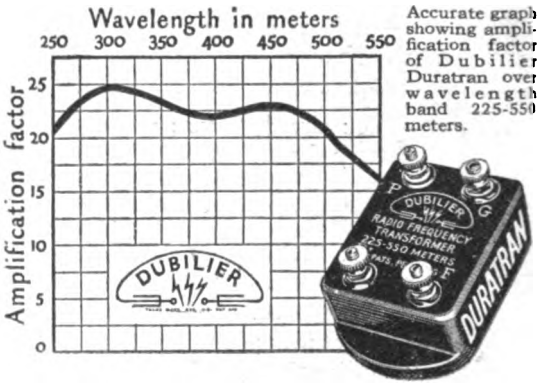
DUBILIER

Radio-Frequency Amplification over all wavelengths



Accurate graph showing amplification factor of Dubilier Duratran over wavelength band 225-550 meters.

The Dubilier Duratran is the supreme radio frequency transformer.

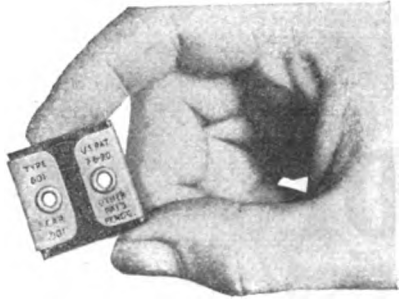
It amplifies twenty times over the wavelength band 220-550 meters and is therefore adapted for receiving on all the broadcasting stations *equally well.*

The curve shows you exactly how uniform is a Duratran amplification over the broadcasting wavelength band.

Price $5.00.

Write for booklet of Duratran hook-ups.

The Biggest Little Thing in Radio



Dubilier Micadons are fixed mica condensers, permanent in capacity.

They have been adopted by the leading radio manufacturers and by discriminating amateurs.

Dubilier Micadons are made in many styles and capacities to meet any circuit requirement.

See if your set is equipped with Micadons. If it isn't, your tubes are probably oscillating too much.

Price 35 cents up.

Write for booklet of Micadon hook-ups.

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DEVICES

The Ducon in a Light-Socket

takes the place of the antenna or loop

The Dubilier Ducon is the standard socket-plug. Four hundred thousand are in successful use.

Simply screw the Ducon in any convenient lamp-socket, and the broadcasting station comes in strong and clear.

With the Ducon you can carry your set to any room, whenever you please, and receive from any lamp-socket.

No lightning arresters or switches are needed.

Tuning is sharper than with the usual antenna.

If unsatisfactory, your money will be refunded after five days' trial.

Price $1.50.

Dubilier Condenser & Radio Corporation

40-50 West Fourth Street, New York

BRANCH OFFICES

Huntington, W. Va., Atlanta, Ga., Pittsburgh, Pa., Chicago, Ill., St. Louis, Mo., Los Angeles, Cal., Washington, D. C.

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Haynes-Griffin

RADIO SERVICE, Inc. **41 West 43rd St., N. Y. City**

A. J. HAYNES
Assoc. Institute of Radio Engineers
Designer of the Haynes Circuit

PARTS FOR THE FAMOUS HAYNES CIRCUIT

1000 Miles for $15.00

The Identical Parts Used by Mr. Haynes in His Own Personal Receiving Set—Assuring the Utmost in Selectivity, Long Distance Range, Economy and Simplicity of Arrangement. Invaluable to experimenters converting ordinary simple regenerative sets to include the Haynes Circuit

LAURENCE M. COCKADAY, R. E., technical editor of "Popular Radio," describes the Haynes Circuit as the ideal set for the average man who demands not only the best in local reception but the extreme in long distance range as well.

Its appeal is universal: to the experienced amateur because of its astonishing long range reception and wonderful selectivity; to the radio novice because of its ease of construction and operation. So simple that no one can possibly go wrong.

The outstanding feature of Mr. Haynes' own set is its simplicity and compactness of arrangement with all the instruments panel mounted.

Most experimenters find it well worth their while to substitute parts recommended by Mr. Haynes for those they may have on hand.

The Haynes Condenser

$3.50

Meets every requirement — extreme low minimum capacity and maximum capacity of exactly .00023 mfds. No other condenser achieves just the right balance between perfect selectivity and overcritical adjustment.

The Haynes Bank Wound Vario-Coupler

$4.35

Furnished with only the taps you actually use and just the right number of turns on the secondary. Bank winding provides 100% efficiency on higher broadcasting wave lengths.

We have on hand a supply of interesting booklets describing the Haynes Circuit. Also a leaflet telling how to build the Haynes Amplifier for use with the Haynes Circuit. These Booklets will be mailed by us anywhere upon receipt of a 2c. stamp for each booklet desired.

Haynes .00023 Condenser	$3.50
Haynes Bank Wound Coupler	4.35
Fada Rheostat	.75
Fada Socket (Panel Mounting)	1.00
Switch Arm	.20
4 Switch Points and 2 Stops	.06
10 Binding Posts	.50
2 3-inch Dials	1.00
1 Dubilier Grid Condenser .00025 mfds. (with leak mounting)	.45
1 Grid Leak 1 meg	.35
Bus Bar, Solder, Copper Lugs and all miscellaneous material	.55
7x15 Grade A Hard Rubber Panel	1.50
Panel Drilled for Mounting all the above instruments (extra)	1.50

Accessories

7 x 15 solid mahogany cabinet, piano finish, $4.25; Haynes-Griffin Head Phones (2200 ohms) $4.75; W. D. 12, U V 201 A or U V 199 Vacuum tubes, $6.50; 22½ volt variable B Batteries, $1.25; 1½ volt dry cell A batteries, 40c each.

Complete parts to build the Haynes Two-Stage Amplifier cost $15.00 additional, including drilled panel. Tubes, cabinet, and batteries are not included at this price.

All these items are in stock—prompt shipment will be made. Carriage charges prepaid anywhere east of the Mississippi River.

HAYNES-GRIFFIN RADIO SERVICE, Inc.

41 W. 43rd St. New York City

New York's Largest Radio Store

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Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

SPECIAL SERVICE TO BUILDERS *of* COCKADAY CIRCUITS

January Popular Radio

IMPROVED FOUR CIRCUIT TUNER—Mr. Cockaday advises many changes from the original design of this world famous circuit, and recommends the use of new and improved apparatus.

November and December Popular Radio

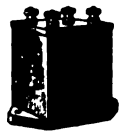
SIMPLIFIED SUPER-HETERODYNE — In these two issues Mr. Cockaday tells how to construct the Separate Oscillator and the Intermediate Wave Radio Frequency Amplifier. These two units, used with the Haynes Circuit, constitute a Super-Heterodyne Receiver.

September and October Popular Radio

THE HAYNES CIRCUIT — These two articles describe the Haynes Circuit—1,000 Miles for $15.00—reviewed in detail on the opposite page of this advertisement.

Haynes-Griffin Transformer

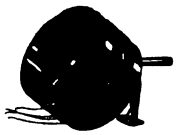
$4.25



A new air core radio frequency transformer sharply tuned to 3,000 meters. Upon the use of this transformer depends much of the success of the simplified Super-Heterodyne. Haynes-Griffin Input Transformer also $4.25.

Special Oscillator Coupler

$3.50



Specially designed by Mr. Haynes for use in the Super-Heterodyne. An indispensable adjunct for the proper operation of this wonderful circuit.

4-Circuit Cockaday Coils	$2.35
Como "Push and Pull" Transformers, pair . . .	12.50

The above is only a partial list of the "hard to get apparatus," now in stock. Send a 2c. stamp for complete price list.

THE IDENTICAL PARTS SPECIFIED BY MR. COCKADAY

Located in New York City, the headquarters of the radio industry, Haynes-Griffin is able to supply immediately each and every article used by Mr. Cockaday in his experimental sets. Every endeavor is made to ship within 24 hours after receipt of order.

Special apparatus designed by A. J. Haynes, and specified by Mr. Cockaday, is now on hand in sufficient quantity to meet the extraordinary public demand.

COMPLETE PRICE LIST

mailed *Free* on request. Leaflets describing the Haynes Circuit, 2 Stage Audio Amplifier, the Separate Oscillator, and Intermediate Wave Amplifier sent on receipt of 2c. stamp for each leaflet desired. Use the handy coupon.

Parcel Post Prepaid in U. S. anywhere east of the Mississippi River

New York's Largest Radio Store

Haynes-Griffin,
41 West 43rd St.,
New York City

Send me at once complete data and prices on all material mentioned in Mr. Cockaday's articles describing the Haynes Circuit and the Super-Heterodyne. I enclose a two-cent stamp for each of the leaflets checked below.

Haynes Circuit ☐ Separate Oscillator ☐
Haynes Amplifier ☐ Intermediate Amplifier ☐

. . . . . .

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HAYNES-GRIFFIN RADIO SERVICE, Inc.
41 West 43rd Street, New York City

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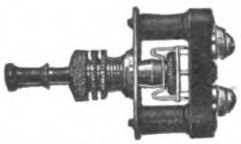
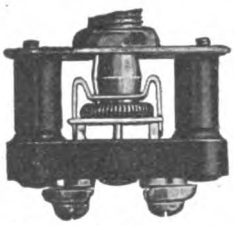
Any set is better with this switch on the panel.

The C-H Radio Switch can be installed on any panel in only a few minutes. Just one 7-16 inch hole is required. Large, convenient binding posts with cupped washers make wiring easy.



The C-H Engineers designed this radio switch mechanism so that the contact member floats, independent of the button. Touching it, or jarring the table does not cause noise in the phones.



The wiping knife-blade type construction insures clean contacts for freedom from microphonic noises.

—and the Same Program Will Be There When You Want It

The Tuning of Your Set Is Not Disturbed When You Have C-H *Control*

The Cutler-Hammer Engineers have provided a real convenience for every panel in the little radio switch which bears their famous signature of approval, the C-H trade mark. They have built it worthy of the finest sets—yet so simple to mount that any one can install it in less than five minutes.

And it can oe used to serve you in many ways. In your "A" battery circuit it makes it possible to interrupt a program without loss of the station received. It protects both your tubes and batteries and indicates at all times whether the current is On or *Off* (with the new tubes that do not burn bright there is no other way of knowing). It is built sturdy to do well any task you may assign, and has broad, self cleaning knife-blade type contacts that give perfect connection and freedom from microphonic noises.

Have your dealer show you the *genuine* C-H Radio Switch. *Snap* the button in and out! You can tell by its action that it was built by switch specialists. Their trade mark on both the dustproof case enclosing the mechanism, and on the bright orange and blue box in which the switch is sold is your protection.

THE CUTLER-HAMMER MFG. CO.

Member Radio Section, Associated Manufacturers of Electrical Supplies

MILWAUKEE · WISCONSIN

C-H RADIO SWITCH

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"I have a Manhattan Loud Speaker in my home because I love fine music"

Ann Pennington

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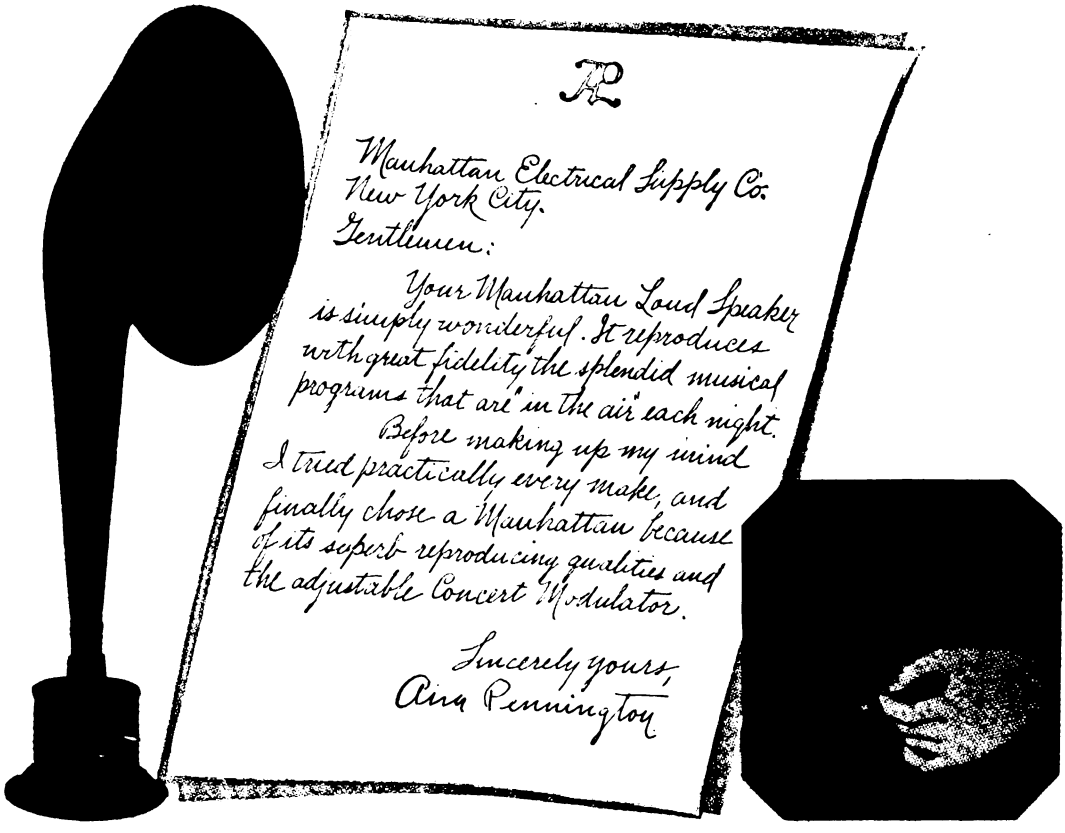
Manhattan Electrical Supply Co.
New York City.
Gentlemen:
Your Manhattan Loud Speaker is simply wonderful. It reproduces with great fidelity the splendid musical programs that are in the air each night.
Before making up my mind I tried practically every make, and finally chose a Manhattan because of its superb reproducing qualities and the adjustable Concert Modulator.
Sincerely yours,
Ina Pennington

Will you make the same test that Miss Pennington did?

Go and hear the Manhattan and you, too, will acclaim it as Miss Pennington did, "a superb musical instrument, capable of reproducing the broadcasting programs with great fidelity."

Go and hear the Manhattan and compare it with others. Compare its mellow richness of tone and its remarkable range, with the reproducing qualities of other instruments. Note carefully its adjustable Concert Modulator that banishes all distortion and makes the Manhattan Loud Speaker adaptable to every condition, so that the best results are always possible.

Go to your nearest dealer and insist upon hearing the Manhattan, "the Loud Speaker with the Concert Modulator." Or write us for descriptive booklets.

Manhattan Electrical Supply Co., Inc.
17 Park Place, New York

Makers of the famous Red Seal Dry Battery

New York Chicago St. Louis San Francisco

MANHATTAN

"The Loud Speaker with the Concert Modulator"

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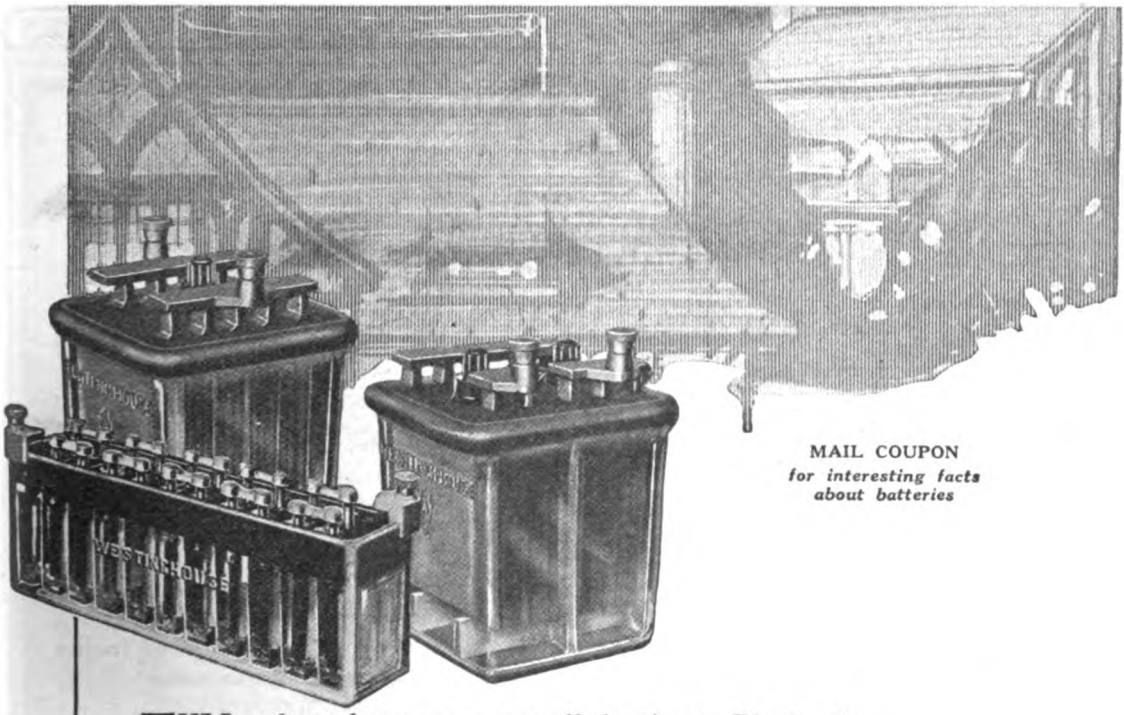

MAIL COUPON
for interesting facts about batteries

FULL voltage battery current all the time! That's what you want. Westinghouse Radio Storage Batteries will give it to you. No more operating with run-down batteries! No more sudden drops in battery voltage! No more throwing away worn-out batteries! Westinghouse Batteries last. They hold their charge. They can be easily recharged. There's a size and type for every radio need. Built by Westinghouse, you *know* it's RIGHT!

Westinghouse CRYSTAL CASE **Batteries** have one-piece clear glass cases, with solid glass cell partitions and high plate rests (deep sediment spaces). Perfectly insulated against current leakage. **"A" Batteries.** 2 volts, for low-voltage tubes, such as WD-11 and WD-12. 4 volts, for tubes like UV-199. 6 volts, for tubes UV-201A or C-301A. Also rubber-case types. **"B" Batteries.** 22 volts. Regular and quadruple-capacity types. **"C" Batteries** in 6-volt units.

WESTINGHOUSE UNION BATTERY CO., Swissvale, Pa.

WESTINGHOUSE

RADIO

"A," "B" and "C" BATTERIES

Westinghouse Union Battery Co.
Swissvale, Pa.
Send me Westinghouse Radio Battery Folder A-3-B.

.....

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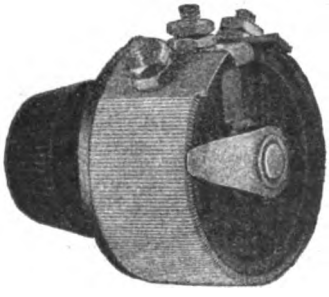
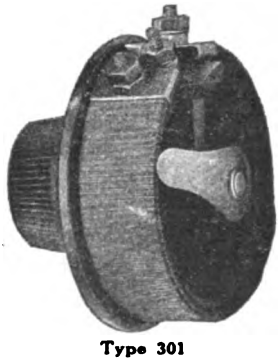
RHEOSTATS - POTENTIOMETERS

General Radio type 214 rheostats and potentiometers are a quality product. The base is made of genuine moulded bakelite and the wire is tightly wound on a specially treated fibre strip. A perfect, non-arcing contact is thus assured.

Where a smaller rheostat or potentiometer is required the type 301 will be found very satisfactory. These units are similar in construction to our type 214.



Type 214



Type 301

The diameter of the 214 rheostat is three inches and that of the 301 is two inches.

G R rheostats and potentiometers also embody—

Fineness in adjustment
Smoothness in operation
Temperature resistance stability

Type		Price
214 A	2 ohm Rheostat	$2.25
214 A	7 " "	2.25
214 A	20 " "	2.25
214 A	50 " "	2.25
214 A	400 " Potentiometer	3.00
301	10 ohm Rheostat	1.25
301	30 " "	1.25
301	200 " "	1.25

Send for bulletin 916U

GENERAL RADIO COMPANY

Massachusetts Avenue and Windsor Street
CAMBRIDGE 39 MASSACHUSETTS

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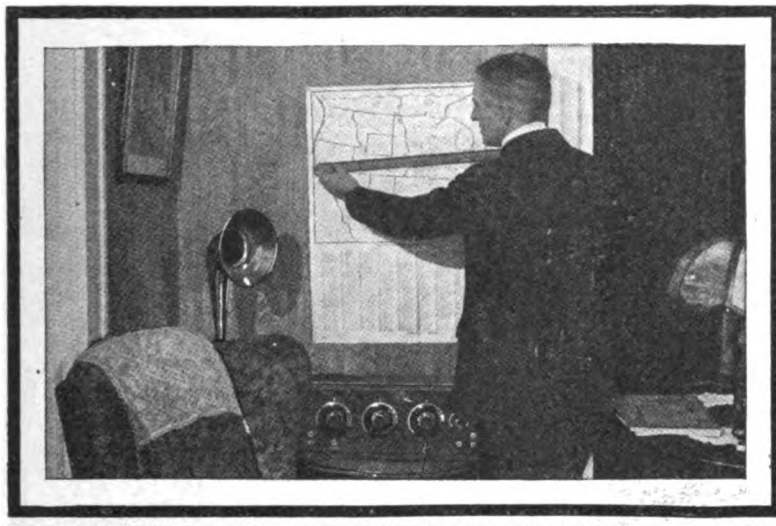

FADA "ONE SIXTY" WITH THE NEUTRODYNE CIRCUIT

Distance

The real thrill of radio is in listening to voice or music on the loud speaker from broadcasting stations located in cities a hundred or a thousand miles away.

To tune them in almost at will is a feature that has made hosts of enthusiastic friends for the FADA "ONE SIXTY" radio receiver. Here is a four-tube receiver combining the famous Neutrodyne circuit with the craftsmanship and experience that have made the name FADA synonymous with quality in radio. It is a receiver that is the equal of any five-tube set of any type or make.

Selectivity, volume, distance and clarity are outstanding features of the FADA "ONE SIXTY" radio receiver. Once the dial readings of any station are recorded that same station can always be tuned in again by returning to the same settings—and almost always with loud-speaker volume. Price, without tubes, batteries or phones, $120 at all dealers.

NOTE—For those who wish to build their own Neutrodyne receivers, FADA Neutrodyne parts are sold at $25; the complete knock-down parts for four-tube set with book of instructions $64; and the complete parts for five-tube receiver at $65.60.

"How to Build It" book—the authority on the Neutrodyne circuit—sold by all dealers or direct for 50 cents per copy.

F. A. D. ANDREA, INCORPORATED
1581 Jerome Avenue, New York City

Fada RADIO

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$25 for $10

Dominating the World

THE ACOUSTICAL AMPLIFIER
BEL-CANTO
TRADE MARK

Direct from Factory to You

NO DEALERS SALESMEN JOBBERS

Their profit is your saving.

This is truly a wonderful opportunity to buy this nationally known speaker at a tremendous saving.

Call at the factory, send us your money order or pay the postmaster $10.00 C. O. D., delivered at your door.

6 Points of BEL-CANTO Superiority

(1) Fiber horn. Crystalline finish.

(2) Our own adjustable loud speaking unit, giving a wide range of tone quality and volume without distortion.

(3) The base is of cast iron, weighing four pounds, eliminating top-heaviness.

(4) All other metal parts are of heavy cast aluminum, highly polished.

(5) Complete instrument stands 24 inches high, 10 inch bell.

(6) Guaranteed for one year from date of purchase against mechanical defects of any kind, and if found mechanically defective within that period of time, we will replace it with a new one without charge to you.

$10

GUARANTEE

Money back any time within ten days if dissatisfied. We further guarantee to the publication carrying this advertisement that each and every speaker sold will be exactly as advertised in this issue.

BEL-CANTO MFG CO.

BENSIL-BONIS CO., Inc.

General Office and Factory: 417-419-421 E. 34th St., Dept. PR, New York City

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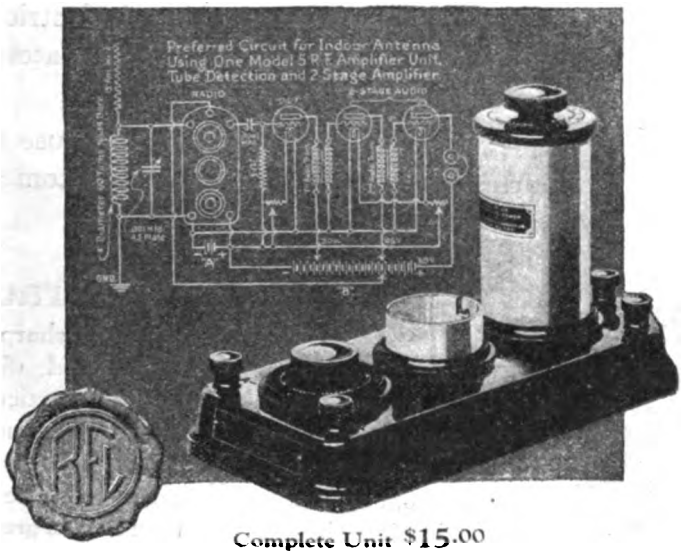
RADIO FREQUENCY AMPLIFICATION

WITH

Ballantine Variotransformers

(Patents Pending)

Model 5 $9.60


Preferred Circuit for Indoor Antenna
Using One Model 5 R F Amplifier Unit,
Tube Detection and 2 Stage Amplifier.
RADIO
2-STAGE AUDIO

Complete Unit $15.00

"TURN THE KNOB"

1. Continuous variation in wave length.
2. Self-contained and shielded.
3. Control of regeneration and tuning by single knob: *no potentiometer.*
4. Fits your set — either base or panel mounting.
5. Improved tone quality.

"Radio Frequency Amplification with the Ballantine Variotransformers" — a 25-page booklet — mailed free on request.

BOONTON RUBBER MFG. CO.

Pioneers in Bakelite Moulding

224 FANNY ROAD BOONTON, NEW JERSEY

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Electrad Products

Their Quality Absolutely Guaranteed

You are safe when you buy Electrad Products. They are absolutely guaranteed, electrically and mechanically, to be of the finest materials and workmanship.

Most good dealers carry them because they are fairly priced, and give their customers good service.

Double Your Distance with an

Electrad Variohm

The latest invention is grid leaks. A simple turn of the knob and you can get any resistance from ½ to 30 megohms. Eliminates circuit noises, is moisture proof and non-microphonic. Absolutely guaranteed.

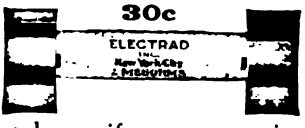
Electrad Lead-in

Fits under closed window. Can be bent to any shape. Covered with fireproof insulation which prevents grounding on wet window sills. No holes in window frames and takes the place of unsightly porcelain tubes. Fitted with Fahnestock Clips.

Electrad Indorarial

Ideal for sharp tuning. Wonderful directional effects. Particularly effective where several local stations are broadcasting at once. Can be used also as ground. By using Indorarials for antenna and ground you can get any coupling you desire. Hang on wall, door or lay under rug.

Electrad Grid Leaks



Absolutely uniform unvarying fixed resistance. A superior product of dependability, in all resistance from ¼ to 10 megohms.

Dealers: Write for samples and details on our special group assortment.

ELECTRAD, INCORPORATED

Department C **428 Broadway, New York City**

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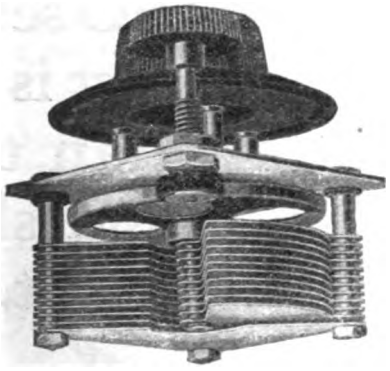
Coto

"Built First to Last"

Stop the Leaks with this Good Coto Air Condenser



THIS high grade condenser often increases signal strength as much as an added stage of Audio Amplification. It takes full advantage of all the energy in the antenna. It avoids the insulation losses that cripple a radio set. The economy is obvious.

Coto Condensers have low losses because of single bearing construction and hard rubber insulation (the best for radio use.) The plates are of copper, soldered together and SILVER PLATED. Strong, handsome and compact, with VERNIER adjustment free from backlash. Moderately priced.

Type 3505 .0005 Mfd. $5 **Type 3510 .001 Mfd. $6**

The Complete Answer to your demand for a real good Variable Condenser. Complete with handsome dial and vernier knob.

Other Coto specialties are Cotogrip Tube Sockets, Moulded Variometers and Variocouplers with GUARANTEED range of 200 to 600 meters covering the broadcasting wave lengths, Tapped Radio Frequency Transformers, Audio Frequency Transformers (Type 4000, $5) and Honeycomb wound Coils.

If your dealer cannot supply you, write us at once giving his name and address and a list of the Coto Radio Parts that you need. You'll get them.

COTO-COIL CO.,

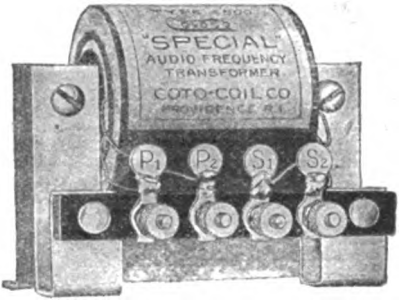
87 Willard Ave., Providence, R. I.

BRANCH OFFICES:

Los Angeles, 329 Union League Bldg.
Minneapolis, Geo. F. Darling, 705 Plymouth Bldg.
Atlanta, C. P. Atkinson, Atlanta Trust Co. Bldg.

Canadian Distributors:

Perkins Electric Co., Ltd.,
Montreal Toronto Winnipeg



Type 4500
The 3 to 1 Ratio
Transformer for All Stages

You can now settle all arguments as to desirable Transformer Ratios in different stages. The question has been needlessly complicated. As usual the simple answer is most economical and best in performance.

Use Coto Specials in all stages and you will be delighted with the ample volume and freedom from distortion. Hundreds of buyers praise them. For reflex circuits they are simply great. Once you have tried them, you will recommend Coto Specials to all your radio friends. **Price $2.50**

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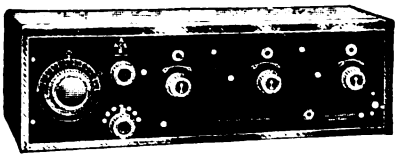
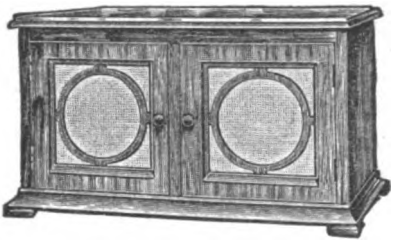
Determining Quality



This new Ace Type 3B Armstrong Regenerative Radio Receiver is the height of perfection. It is equal to a combination of the Ace Type V and the Ace two-stage amplifier. For volume and distant reception it out-performs most sets costing a great deal more. The new Ace Type 3B has a filament switch which eliminates necessity of turning out rheostats when set is not in use. Sells for $50.00 but worth much more. Has genuine mahogany cabinet with engraved panel.



ACE TYPE 3C CONSOLETTE

This is the last addition to the Ace Family. Has beautiful solid mahogany, wax finished cabinet. Set consists of a regenerative tuner, detector and two stages of amplification with built-in loud speaker. Due to the particular method of winding Crosley coils it is exceptionally selective. Has sufficient room inside Cabinet for dry batteries, making a complete self-contained long range receiving outfit. Phone jack for tuning with head phones; Crosley multistat; filament switch, engraved Formica panel. Uses all kinds of tubes. An efficient set at a remarkable price, $125.00—without tubes or batteries.

Your dealer can supply you. Ask for "Simplicity of Radio" —your copy is *free*.

DEALERS: Write on your letterhead for attractive sales proposition.

A RADIO set or product is no better than the science and skill that creates it.

Those men in this Institution who are intrusted with the responsibility of producing up to the standards of Powel Crosley, Jr., are experts who have won national recognition in their chosen scientific field.

Honest Merchandise uses Truth in Advertising

Ace Type 3B and Ace Type 3C Consolette manufactured under Armstrong U. S. Patent No. 1,113,149

THE PRECISION EQUIPMENT CO.

316 VANDALIA AVE. POWEL CROSLEY, JR., Pres. CINCINNATI, OHIO

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The WANDERING MINSTREL of TODAY

HOW far have we progressed from the days when the minstrels, singing their self-composed ballads to the accompaniment of harp or lute, or telling their stories illustrated with crude mimicry, wandered from castle to castle in old England furnishing to the nobility practically the only entertainment available.

Today every American, no matter how far removed from the centers of activity, has within his reach up-to-the minute news and amusements that would have delighted the hearts of the nobility of old. The air is filled with merriment waiting to be captured and brought to your very fireside.

Radio is the magic wand that attracts to you the desired entertainment. Crosley Radio Receivers are the instruments by which this entertainment may be clearly and distinctly converted into a true reproduction of the original voice thousands of miles away.

You can own and enjoy a Crosley Radio Receiver. Unique features and quantity production have enabled us to offer the greatest value in radio ever produced. Actual tests by hundreds of satisfied users in all parts of America have proven that in performance, Crosley Instruments are unexcelled. And the prices are remarkably low.

CROSLEY

MODEL VI Two Tube Set **$30**
MODEL X-J Four Tube Set **65**
MODEL X-L Four Tube Set **140**
With Built-in Loud Speaker

CROSLEY
Better-Cost Less
Radio Products

Special mahogany stand for Model X-L, $25 extra

Cost of necessary accessories $40 up

MODEL VI—$30. A wonderfully efficient two tube set, one stage of Tuned Radio Frequency Amplification and Detector.

MODEL X-J—$65. A four tube radio frequency set combining one stage of Tuned Radio Frequency Amplification, a Detector and two stages of Audio Frequency Amplification. A jack to plug in on three tubes for head phones, the four tubes coupled up for loud speaker.

MODEL X-L—$140. A duplicate of Model X-J except the arrangement and mounting into a beautiful cabinet with the addition of a built-in loud speaker and space in the cabinet provided for housing the necessary batteries.

Crosley Manufacturing Company owns and operates broadcasting Station WLW

Let a Crosley Radio Receiver Bring Perpetual Entertainment to Your Home.

For bringing in distant stations no set can excel it
For Sale By Good Dealers Everywhere

Crosley Manufacturing Company

Largest manufacturers of Radio Receivers in the World
Powel Crosley, Jr., President
216 Alfred Street **Cincinnati, O.**

Mail This Coupon Today

Crosley Manufacturing Company
Powel Crosley, Jr., President
216 Alfred St., Cincinnati, Ohio

Gentlemen:
Please mail me free of charge complete catalog of Crosley instruments and parts. I enclose 10c for which also send your booklet entitled "The Simplicity of Radio" by Powel Crosley, Jr.

Name.....

Address.....

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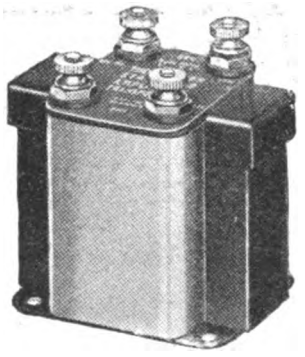

YOUR SET WILL BE A MUSICAL INSTRUMENT

WHEN YOU USE

THE THORDARSON SUPER

AUDIO FREQUENCY AMPLIFYING TRANSFORMER

Heretofore, amplifying transformer manufacturers have given too much attention to volume of amplification and have sacrificed the most important function of their transformers,—that of perfectly reproducing the broadcasted programs. Consequently many listeners in have complained about the musical qualities of radio reception.

No matter how good your phonograph, you could not expect to obtain good music from a poor record. Likewise, although your loud speaker be the best, you cannot expect to enjoy radio reception if the signals you put into it have been distorted in the process of amplification.

The new THORDARSON SUPER Audio Frequency Transformer was designed to correct the shortcomings of amplifying transformers of the past and embraces the following cardinal features:

(1) **Perfect reproduction of voice and instrument**
(2) **Even amplification over the entire musical range. (You will be surprised to hear the amazing reproduction of the bass notes.)**
(3) **Increase in volume to the extent that tonal purity will permit.**

This SUPER TRANSFORMER is the result of several months research work in the thoroughly equipped Thordarson laboratory and represents the culmination of twenty-eight years experience in manufacturing small transformers.

Such leading set manufacturers as the Colin B. Kennedy Company, Chicago Radio Laboratories Company (Zenith) and the Western Coil and Electric Company (Radiodyne) along with many others proclaim the merits of the THORDARSON SUPER TRANSFORMERS.

Install a pair of Thordarson Super Transformers now and your receiving set will be converted into a real musical instrument.

YOUR DEALER HAS THEM

THORDARSON
ELECTRIC MFG. CO.

CHICAGO, ILLINOIS

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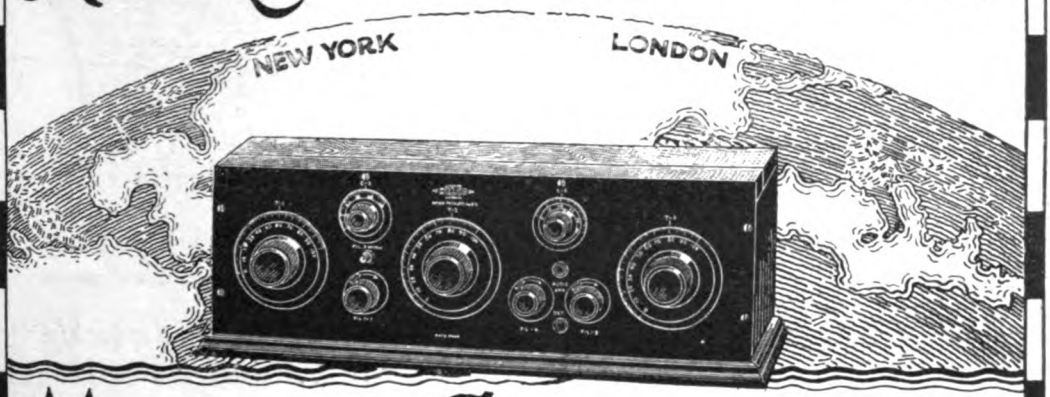
Now Links Two Continents!



MELCO-SUPREME

Tuned Radio-Frequency RECEIVER

Satisfies Every Radio Wish

D X performances by enthusiastic owners prove conclusively that the MELCO-SUPREME is in a class by itself when it comes to

REAL LONG DISTANCE RECEPTION

Brookfield, Mo.	to	Glasgow, Scotland
Brooklyn, N. Y.	to	Los Angeles, Cal.
Cleveland, Ohio	to	Havana, Cuba
Portland, Ore.	to	Schenectady, N. Y.
Leechburgh, Pa.	to	Dallas, Texas
Porto Rico	to	Philadelphia, Pa.

(Names and addresses on request)

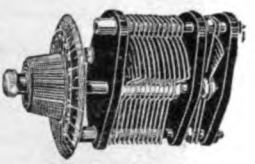
Extreme Selectivity — Exceptional Clarity — Simplicity of Operation

Write for complete descriptive literature

AMSCO

Rheostats and Potentiometers

With knob or dial—suitable for either table or panel mounting.



Variable and Vernier Condensers

Precision-made for accurate tuning.

Amsco quality apparatus has been selected by Mr. Laurence Cockaday for use in his new Improved Four Circuit Tuner as described in detail in the January issue of Popular Radio.

AMSCO PRODUCTS, Inc.

FAIRBANKS BUILDING

BROOME & LAFAYETTE STS. NEW YORK CITY

GIELCO

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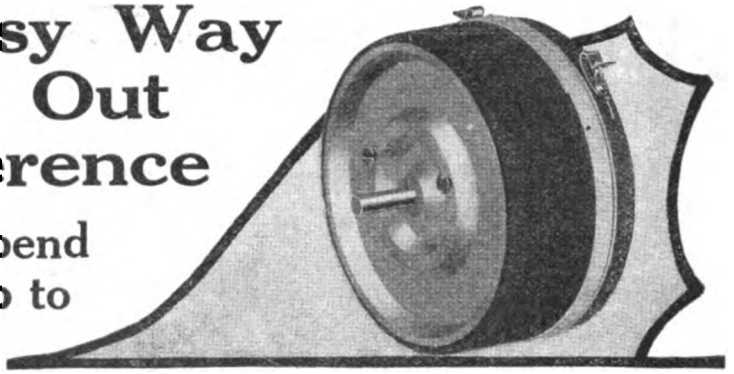
An Easy Way to Cut Out Interference

Add a Ferbend Wave Trap to Your Set



Enjoy your radio set. Get the station you want, *quickly*. Listen in on one thing at a time without annoying squawk-k-k-s or irritating whistles.

The Ferbend Wave Trap Makes Every Night Silent Night

New radio broadcasting stations are making receiving constantly more difficult. Many owners of long-distance sets are discovering powerful amplification is of little value so long as local stations are "all over the dial." Hundreds of users have solved the difficulty with the Ferbend Wave Trap—the missing link in Radio. A St. Louis user reports: "Heard Havana clearly with three St. Louis stations broadcasting. My receiver works like a new set. The 'Ferbend' is certainly a wonder!"

YOU Can Obtain These Remarkable Results

You can obtain results as satisfactory as this St. Louis user. If you don't, it doesn't cost you a penny for the "Wave Trap" is sold with a positive guarantee that it will tune out your powerful local stations. Don't wait. Order now at our risk.

SEND NO MONEY

You need not send a penny. Pay Postman $6.00 (plus postage). If you prefer, send $6.00 with order and Wave Trap is mailed *postpaid* ready for panel mounting. Money back guarantee either way. You see you take no risk, so order TODAY.

FERBEND ELECTRIC CO.
21 E. South Water St. Chicago

Ferbend Electric Co.
21 E. South Water St.
Chicago

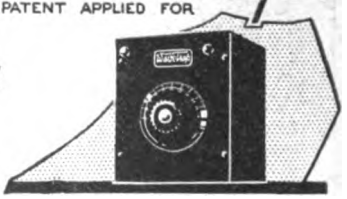
Send me a Ferbend Wave Trap. I will pay Postman $6.00 (plus postage). I understand you guarantee the "Wave Trap" to tune out my local stations or my money will be refunded.

Name .....

Address .....

FERBEND
TRADE Wave Trap MARK
PATENT APPLIED FOR

The Original Wave Filter



The Ferbend Wave Trap can also be supplied completely mounted ready for instant use on formica panel in mahogany finished cabinet, 6 x 5 x 6. $8.50. Get full benefit of all the distance your set will give you. Order your Ferbend **TODAY.**

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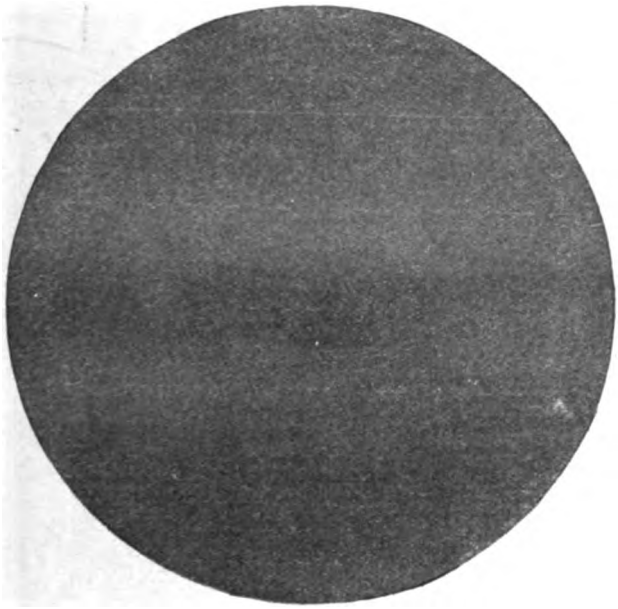

3⅛ inches actual size of diaphragm in Timmons Talker

On Any Radio Set

Why the extra large diaphragm of Timmons Talkers give such wonderful volume

Sounds from a loud speaker are caused by the diaphragm vibrating and displacing air. The more air the diaphragm displaces the greater the volume.

Timmons Talkers have an especially large diaphragm (3⅛ inches). This enables them to displace a great amount of air and in consequence give exceptional volume without forcing tubes. And, as you possibly know, it is the forcing of tubes that causes most distortion.

We would like you to hear Timmons Talkers and know for yourself their great volume and wonderfully clear tone.

Your dealer will be glad to let you hear a Timmons Talker in a comparison test with any loud speaker in his place. He will also give you our folder, "Volume without Noise" or write us. Type A (adjustable) $35; type N (non-adjustable) $25.

The most beautiful loud speaker in the world

J. S. TIMMONS

330 E. Tulpehocken St. Germantown, Phila., Pa.

Timmons Talkers

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What's Inside

THE most important thing to know about an amplifier is "What's Inside." Outwardly there is little vital difference. Inwardly there's all the difference in the world — the difference between clear, mellow reception and poor reception full of squeaks and squawks.

Many radioists unconsciously put the "squeaks and squawks" into their sets through the use of improper transformers. They have yet to learn that "RATIO" means absolutely nothing — that 10 to 1, 9 to 1, etc., do not spell maximum amplification.

The very next time you buy an amplifier insist on a Genuine JEFFERSON for these reasons:

1st — A JEFFERSON is scientifically designed.

2nd — The windings are carefully calculated to produce 100% amplification —they are not built up to a ratio.

3rd — The JEFFERSON line embraces a variety of amplifiers to meet every demand—six Audio and two Radio Frequency types.

As pioneer transformer manufacturers JEFFERSON Engineers designed audio amplifiers long before Radio reached its present popularity. You will appreciate JEFFERSON'S extra years of experience.

And remember this — the first cost of an amplifier is unimportant. Results count — buy an amplifier for what it will do — the service it will render — the tone and volume it will produce. Receiving is fun when one doesn't have a lot of pesky distortion to struggle with. You eliminate distortion when you use JEFFERSON. Your set operates more quietly and clearly — the volume is greatly increased — distant stations are easily tuned in.

You are invited to write our Radio Engineering Department for amplification data. Attractive descriptive literature is also available. This service is gratis.

JEFFERSON ELEC. MFG. CO., 427 South Green Street, Chicago, Ill.

Jefferson Super-sensitive Amplifying Transformers

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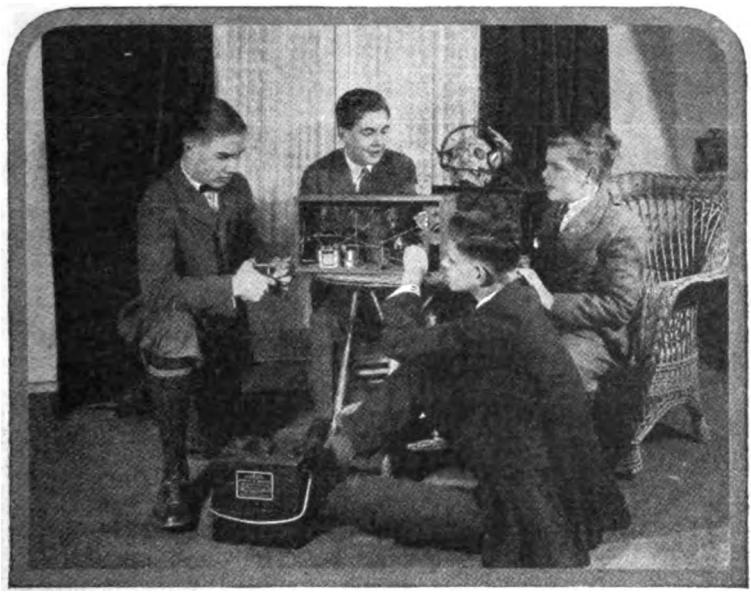

Radio is a triumph of Youth

The great names in radio are those of young men—men who, as boys, made invaluable contributions to the development and perfection of this still new wonder. Armstrong, Cockaday, Tuska, Reinartz—starting with crystal sets—brought out their inventions when in their 'teens, or early twenties. The imagination, perseverance and eternal curiosity of boyhood kept them experimenting, testing, striving for improvement.

The spirit of boyhood has not changed. Millions of boys to-day, starting with crystal sets, work their own way up the ladder. Their hoarded savings go for the parts with which to build. Success leads them to new efforts. Parents, interested, buy them better, more expensive sets to experiment with. But each new set is but the starting point for further improvement. Boys are never satisfied—their curiosity will not let them be.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

is radio authority and mentor to 500,000 wide-awake, aggressive, radio-saturated boys, averaging 15½ to 16 years old. Some of them are at the bottom of the radio ladder—starting with cat's-whiskers. The vast majority are advanced radio enthusiasts who naturally turn to THE AMERICAN BOY'S stories and articles for new suggestions, new methods—and turn to its advertising columns for the newest and best radio equipment.

Half a million sons of well-to-do parents are buying somebody's radio products—spending their own money and getting their parents to spend for them. Brand the radio wants of this vast army of AMERICAN BOY readers with your name. Win their good-will and loyalty. Open your door to their tremendous trade by advertising your products in their own respected magazine—THE AMERICAN BOY.

THE SPRAGUE PUBLISHING COMPANY

(Member A.B.C.)

548 Lafayette Boulevard, Detroit, Mich.

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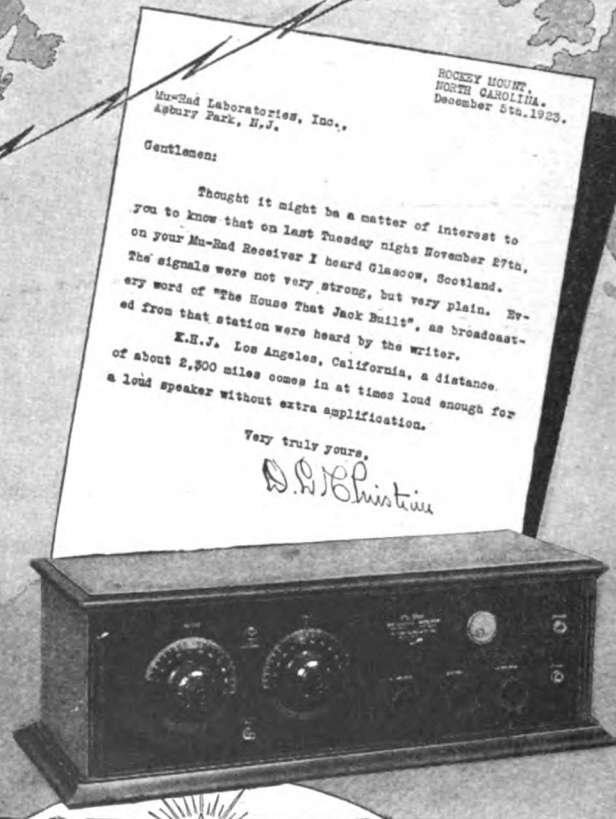
A Trans-Atlantic Triumph


ROCKEY MOUNT,
NORTH CAROLINA.
December 5th.1923.
Mu-Rad Laboratories, Inc.,
Asbury Park, N.J.
Gentlemen:
Thought it might be a matter of interest to you to know that on last Tuesday night November 27th, on your Mu-Rad Receiver I heard Glascow, Scotland. The signals were not very strong, but very plain. Every word of "The House That Jack Built", as broadcasted from that station were heard by the writer.
K.H.J. Los Angeles, California, a distance of about 2,300 miles comes in at times loud enough for a loud speaker without extra amplifiation.
Very truly yours,
D.S.McChristie

Over 3600 Miles

MU-RAD RECEIVER

A DESCRIPTION of actual **Mu-Rad** performances, without such supporting evidence, might seem exaggerated. The New Mu-Rad MA-15, a **long range receiver,** adds to the well known **sensitivity, easy operation** and **selectivity** of Mu-Rad receivers, **loud speaker volume** with only a **2 foot loop.** Detector, three stages of radio frequency and two stages of audio frequency amplification. **1,000 miles Reception Guaranteed.** Write for Literature.

MU-RAD LABORATORIES, INC.

809 FIFTH AVE. ASBURY PARK, NEW JERSEY

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Use Graphite Disc Rheostat
Says prominent radio expert

RADIO FACTS FOR EVERYBODY; NEWS AND THEORY OF WIRELESS

While Nearly All Standard Tubes Will Give Good Results, Low Vacuum Type Is Best, Says Calcaterra.

LOW VACUUM TUBE IS BEST.

All Standard Tubes, However, Will Give Good Results.

BY JOSEPH CALCATERRA.

(Radio author.)

Another important consideration in getting maximum efficiency from a given tube is choice of the standard tubes which will give good results. While practically all the standard tubes now on the market will give good results, there is one tube which gives best results. That tube is the soft or low vacuum tube especially designed for detector use. UV-200 and C-300 tubes are of this type.

In tool making and high class instrument making best results are obtained only when the best tools and most painstaking methods are used. So also in radio receiving, exceptional results are obtained only when corresponding care is taken. The hard or high vacuum amplifier tubes can be used as detectors and their characteristics are such that a critical adjustment of grid, filament and plate currents are not required. With the soft tubes, however, best results are obtained only when these...

For Use Vernier Rheostat.

For adjustment of filament temperature, to obtain the best operating point of the tube, a Vernier rheostat, preferably of the carbon pile resistance type, should be used. Care must be exercised not to burn out the filament. The rheostat should be placed in the return from the secondary circuit to the filament, should be made to the positive lead of the "A" battery.

The rheostat should be placed in the negative lead of the "A" battery, that is between the negative of the "A" battery and one of the filament terminals of the socket.

While a considerable change in the plate voltage applied in the plate circuit of a hard or amplifier tube when used as a detector will make very little difference in the operation of the tube, the soft detector tube is very responsive to slight changes in the plate voltage. The characteristics of different tubes of the same type vary to some extent, so that a fine variable adjustment must be provided to take care of the individual requirements of the tube used.

Can Vary Adjustment.

Usually the best point will vary from 18 volts to 22½ volts. The adjustment can be varied to a certain extent by varying the lead from the plate circuit to the positive end of the battery on the different taps provided on practically all "B" batteries. In most cases, however, a finer adjustment than the 1½ volt steps provided by the taps is required and this can be obtained by the use of a potentiometer.

One end (either end, may be used) of the resistance element of the potentiometer is connected with the positive end of the "A" battery and the other end of the resistance element is connected with the negative lead of the "A" battery.

The negative of the detector circuit with the filament circuit, as is done in most cases, is connected with the movable arm or contact of the potentiometer. The big variations in the plate voltage are obtained by moving the positive "B" battery lead to different taps or

Clipping from Chicago Daily News October 24, 1923

Good for ALL tubes

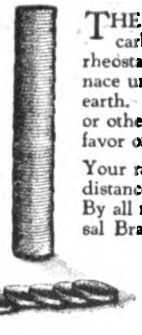
Retail Price $1.85

IN CANADA $2.50
POSTAGE 10¢ EXTRA

What Is Meant by a "Carbon Pile" Rheostat?

MORE than 20 years ago, the Allen-Bradley Co. developed a successful compression rheostat for big power circuits. It was made of flat carbon discs and the electric current flowing through the column was regulated by applying or removing pressure on the discs. The idea of the carbon pile was not new, even then, but successful commercial rheostats were unknown.

Graphite discs, however, soon replaced the carbon discs and to this day all Allen-Bradley rheostats are *graphite disc* rheostats, although many prominent engineers still speak of them as carbon piles.



THE Universal Bradleystat is sometimes called a carbon-pile rheostat. It is, however, a *graphite disc* rheostat. The discs are produced in an electric furnace under the most terrific temperatures known on earth. Carbon discs, carbon powder, metallic powder or other materials have long since been abandoned in favor of the reliable and noiseless *graphite discs*.

Your radio set needs a Universal Bradleystat for long-distance range, loud reception and noiseless control. By all means, avoid substitutes. Insist on the Universal Bradleystat.

The *Bradleystat* Won First Place

in the Radio Broadcast long distance contest. The first prize winner used a Bradleystat and the greatest mileage record was made with a Bradleystat.

More Bradleystats were used in this contest than the next four types combined. Bradleystat supremacy has become an actual fact through sheer force of superior performance.

Allen-Bradley Co.
Electric Controlling Apparatus
MILWAUKEE, WISCONSIN

276 Greenfield Ave. A-B Milwaukee, Wis.

Just Mail This Coupon!

Allen-Bradley Co.,
276 Greenfield Ave., Milwaukee, Wis.

Please send me your latest bulletin on the Universal Bradleystat and why it improves radio reception.

Name .....

Address .....

.....

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Reduce Tubes by Half

With Erla Synchronizing Transformers

Vacuum Tubes in ERLA Duo Reflex Circuits

1 = 3
2 = 4
3 = 5

Vacuum Tubes as Ordinarily Employed —

Increased amplification and elimination of distortion inevitably follow installation of Erla transformers. Reflex and cascade types. $5

Crystal troubles vanish on installing an Erla rectifier. No adjustment required. Proof against jolt and jar. Lasts indefinitely. List $1

Look for the words "tested capacity," found exclusively on the labels of Erla fixed condensers. Made in eleven sizes, 35c to 75c ea.

Nation Wide Loud Speaker Reception With Only Three Tubes

Greater range and volume with fewer tubes than ever before are attained through Erla Duo-Reflex circuits, using Erla synchronizing radio and audio transformers.

In Erla circuits, tubes do triple duty, as simultaneous amplifiers of received radio frequency, reflexed radio frequency, and reflexed audio frequency currents. Through accurate superimposition of currents identical in phase and frequency, by means of Erla synchronizing transformers, this triple function is flawlessly performed, resulting in tremendously magnified amplification without distortion.

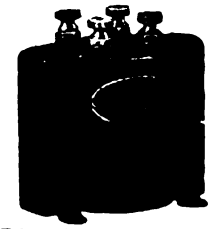
Even one tube provides excellent loud speaker reception over a wide range; two tubes blanket the zone ordinarily covered by four, while three tubes bring in stations on the loud speaker from coast to coast.

Other notable improvements, contributing vitally to the superiority of Duo-Reflex circuits, are the Erla fixed crystal rectifier and Erla tested capacity condensers. Combining advanced characteristics for reflex work with unduplicated uniformity, they are indispensable to complete stability and purity of reproduction.

Detailed diagrams and descriptions of Erla Duo-Reflex circuits are presented in Erla Bulletin No. 16. Ask your dealer, or write, giving your dealer's name.

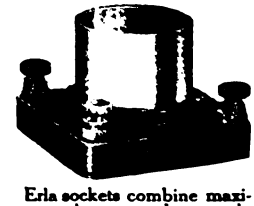
Electrical Research Laboratories
Dept. R 2515 Michigan Avenue, Chicago

ERLA



Erla audio transformers add tremendously to the purity and volume of any receiving unit in which they are used. Ratios 3½ and 6 to 1. $5

Screen unsightly openings for tube ventilation with Erla bezels, made in 1" and 1½" sizes, in bright nickel or dull enamel. List, 20c



Erla sockets combine maximum beauty and strength, with heavy, nickeled shell cast into moulded Bakelite base. Many other advantages. 75c

The Copper Giant "A" Battery

For WD11, WD12 and other low voltage tubes. Equal to 20 dry cells. Can stand idle for years without deterioration and requires no attention whatever. Ideal for multi-tube circuits using UV199. Write for circular.

THE COPPER GIANT BATTERY CO., Lansdowne, Pa.

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Booklet "More Light on Patents" Sent Free

MAX D. ORDMANN, Reg. Pat. Lawyer,
Mech. and Elect. Engineer,
Specializing in Radio
1503 Woolworth Bldg., N. Y. City Tel. Whitehall 7040-1

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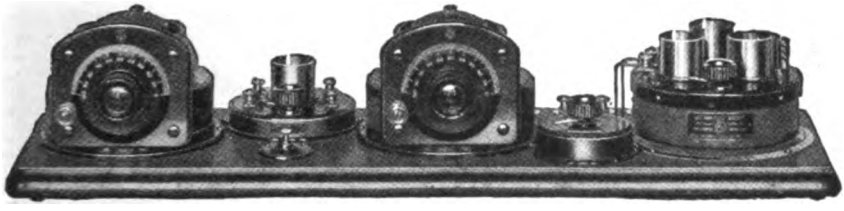
ATWATER KENT

RADIO EQUIPMENT



Atwater Kent Model 9 Receiving Set

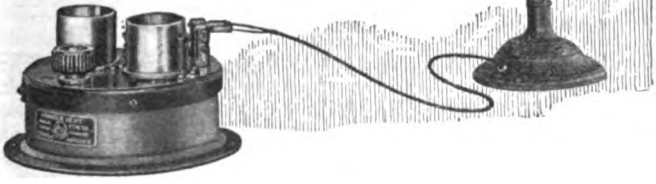
Clear Reception Without Annoying Interference

THE ATWATER KENT Model 9 is an easily operated, highly efficient receiving set which gives excellent loud speaker performance on distant broadcasts. With this instrument it is easy to return to the dial settings once they have been noted.

You will find the fidelity with which the ATWATER KENT Loud Speaker reproduces tones delightfully pleasing. No batteries required.

ATWATER KENT Equipment embraces a variety sufficiently wide to meet the requirements of every user of radio. It includes complete sets and every instrument necessary for the assembling of sets from tuning unit to loud speaker.

Phonograph Attachment



If you are now working with a one-tube set, the ATWATER KENT 2-Stage Amplifier will give you the necessary volume to use a loud speaker.

Literature describing the entire line of Atwater Kent Radio Sets and Parts sent on request

ATWATER KENT MANUFACTURING COMPANY, PHILADELPHIA, PA.
4933 STENTON AVENUE

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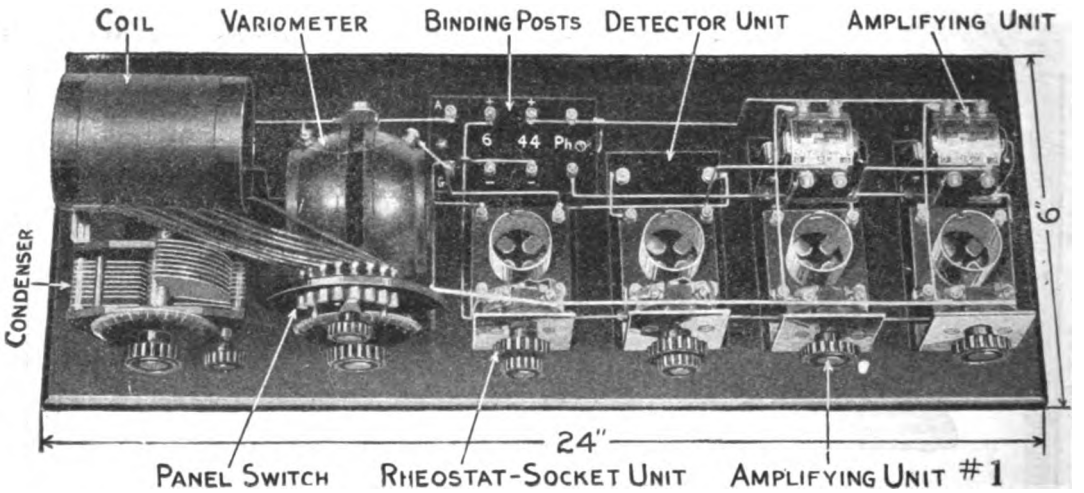


Tuned Wave Trap Radio Frequency Receiver

BUILT ON FAMOUS COPP CIRCUIT No. 4

1 Stage Radio-frequency—2 Stages Audio-frequency

Efficient for all wave-lengths from 200 to 700 meters

Range up to 2000 miles

Any person can build the above set with A-C DAYTON Complete Units

$43.35

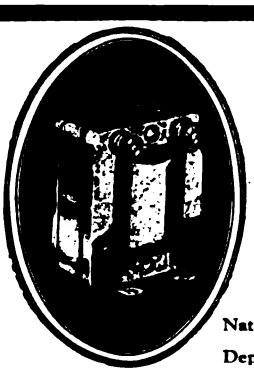
Units packed complete in one carton with wiring diagrams, photographs, instructions, etc., for complete installation.

SEE YOUR DEALER OR WRITE US DIRECT

We manufacture a complete line of Radio Parts and Units—Catalog on request

THE A-C ELECTRICAL MFG. CO., Dayton, Ohio

Makers of Electrical Devices for over 20 Years.



National Audio Frequency Transformers

The New 6 to 1 Ratio National Transformer is for use on the first stage of amplification. Its greater ratio means increased volume, but the tone qualities that characterize the 3½ to 1 ratio have been fully retained. Price of 6 to 1 ratio $4.50 postpaid; of the 3½ to 1 ratio, $4.00 postpaid. *Dealers: Write for interesting sales proposition.*

National Transformer Mfg. Co.
154 Whiting Street
Dept. 211 Chicago, Ill.

NA-ALD De Luxe Dials

The artistic qualities of Na-ald De Luxe dials distinguish these dials as truly beautiful. They add to the appearence of any set in which they are used.
Na-ald Dials have a high gloss finish. They are moulded of genuine Bakelite and have patented construction. Dials are matched and made in 2", 3", and 3¾" sizes.

Alden Manufacturing Company
Largest makers of Radio sockets and dials in the world
Dept. C 52 Willow St.
Springfield, Mass.

No. 3003—4
3 Inch
35c, 3 for $1.00

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After Painting by John Trumbull

The Golden Rule Tube

The Sodion does not oscillate.

No declaration as to sensitivity, signal strength—or quality of tone—can mean half so much to every broad-minded radio enthusiast as this simple statement of fact.

For there—in five words—you have the key to the solution of the problem of eliminating the whistles, the squeals and the howls that interfere so seriously with your enjoyment of radio today.

Don't misunderstand—

The Sodion does not protect YOUR reception against these noises from other sets.

But, because it does not oscillate—because it cannot reradiate—because it cannot whistle and howl—the Sodion DOES prevent your reception from interfering in any way with the reception of others.

This, we believe, is the practical way of eliminating one of the greatest faults in broadcast Radio reception.

In point of efficiency the Sodion Tube is far more sensitive and produces stronger signals than any detector now on the market. Its tone is fully equal to that of the finest crystal with the added advantage of great volume.

Descriptive Bulletin upon request.

CONNECTICUT TELEPHONE & ELECTRIC COMPANY
MERIDEN Radio Division CONNECTICUT

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WANTED! WANTED!

A NAME

to replace the Name "Acmedyne"

A set of essential parts for the above circuit will be given to the person furnishing the best substitute.

Write for rules governing the contest.

Closing Date February 15th, 1924

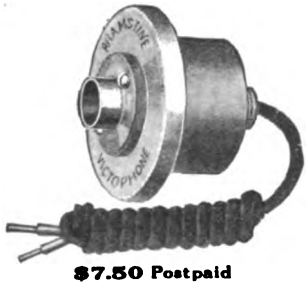
DANZIGER-JONES, Inc.

25A Waverly Place **New York City**

RHAMSTINE★

Presents the New VICTOPHONE

—for all Phonograph and Loud-Speaking Horns



$7.50 Postpaid
Complete with Cord

Relentless research in the field of loud-speaker units has resulted in Rhamstine★ achieving the ultimate in tone and volume. The New Victophone will exceed your expectations; you will appreciate its superiority upon comparison with other loud-speakers. Every part of this new Phonograph unit was designed and built to excel in efficiency and in beauty all other makes. It can be furnished to fit all phonographs — the Standard Type fits the Victrola, Columbia, Jewett or Sonora. Specify make of phonograph when ordering. List Price, Standard Type, $7.50.

Order the New Victophone and test it before buying any other loud-speaker

The Rhamstine★ Electric Solder Set

New Round Type

$2.50 Postpaid
Complete with Cord, two-piece Plug and Solder

Here is the new model—round type—electric solder set. A more handsome and heavier iron than the original flat model. The tip is easily replaced when worn out. Especially adapted for radio work. It is highly plated and polished. Can be used on 110 volts A. C. or D. C. Guaranteed one year. Order an electric solder set and solve your soldering problems. Only $2.50 postpaid.

Manufactured by

J. THOS. RHAMSTINE★

Woodbridge at Beaubien **Detroit, Michigan**

**Maker of Radio and Electrical Products*

Please refer to POPULAR RADIO *when answering advertisements.*

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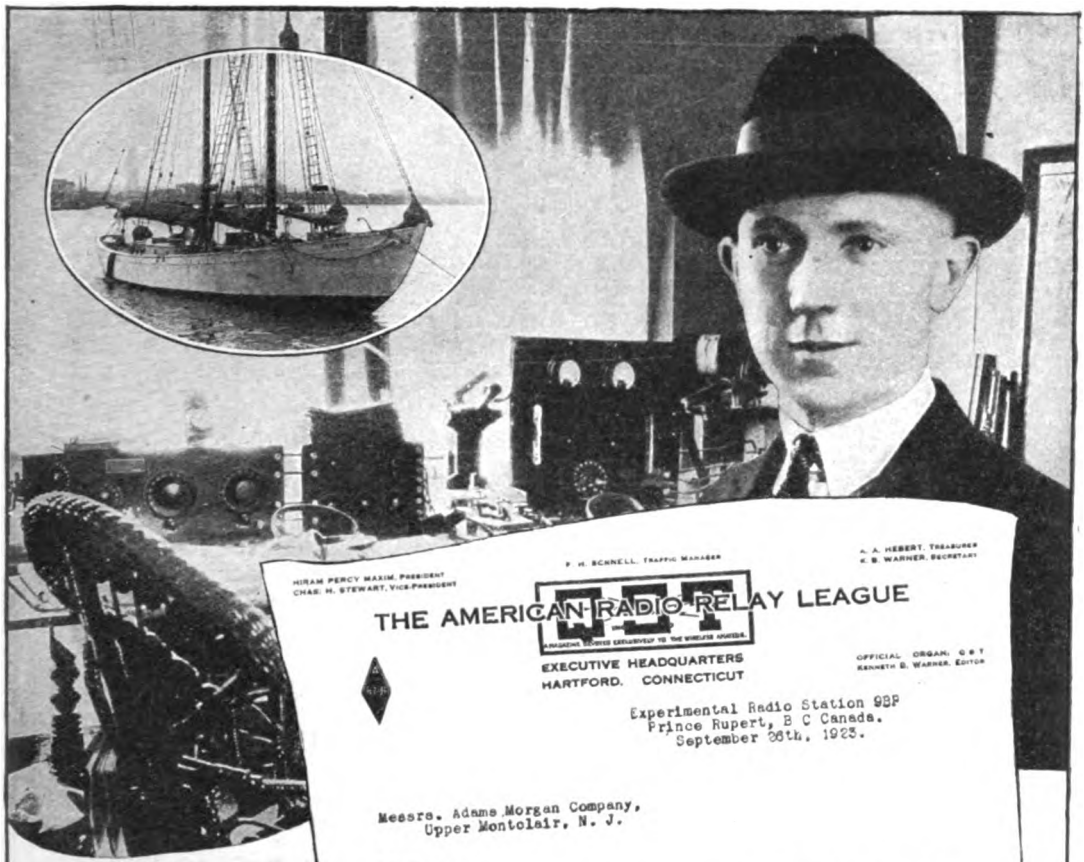

MacMillan's Link with Civilization

A Paragon Radio Receiver is the most dependable link between MacMillan's courageous explorers and a civilization eager to hear of their doings.

Read this letter from Jack Barnsley whose Paragon Receiver has been picking up these vitally important messages, picking up every one, and getting every word clearly.

A Radio Receiver could have no higher recommendation.

Illustrated Bulletins on Paragon Radio Products are yours for the asking.

ADAMS-MORGAN CO.,
20 Alvin Avenue,
Upper Montclair, N. J.

HIRAM PERCY MAXIM, PRESIDENT
CHAS. H. STEWART, VICE-PRESIDENT

F. H. SCHNELL, TRAFFIC MANAGER

A. A. HEBERT, TREASURER
K. B. WARNER, SECRETARY

THE AMERICAN RADIO RELAY LEAGUE

EXECUTIVE HEADQUARTERS
HARTFORD, CONNECTICUT

OFFICIAL ORGAN: A.R.R.L.
KENNETH B. WARNER, EDITOR

Experimental Radio Station 9BP
Prince Rupert, B C Canada.
September 26th, 1923.

Messrs. Adams Morgan Company,
Upper Montclair, N. J.

Dear Sirs:-

I have advised you before that I am very pleased with the results of my "PARAGON APPARATUS" but here is another victory for "PARAGON APPARATUS" which I feel you will be interested to know.

The MacMillan Arctic Expedition which left Wiscassett, Maine on June 23rd. on board the radio equipped Schooner "Bowdoin" planned to keep in touch with the outside world by amateur radio. This they were able to do until they got North of Disco Island, Greenland. After going North of that point nothing was heard of the expedition. And all interested became worried at the ship's apparent silence. The Chicago Radio Laboratory on this account offered a duplicate of the receiving apparatus aboard the "Bowdoin" as a prize to the first amateur to get into communication with the Arctic Expedition. This prize I have had the honor to win with the aid of my PARAGON Type RA-10 Regenerative Receiver and PARAGON Type DA-2 Detector-Amplifier.

Since first getting into communication with the "Bowdoin" expedition(who are in winter quarters frozen in at Refuge Harbour, which is ten miles North of Greenland Latitude 78.30 North, Longitude 72.30 West) on September 7th. I have had a working schedule with the operator and have copied one 600 word and one 181 word press message from them addressed to the New York World, together with dozens of private messages from the expedition and a complete list of amateur calls heard (a total of 546 calls) by the "Bowdoin" from July 28th to September 20th. and have forwarded all of these messages to their destinations.

When you consider that the expedition has heard hundreds of amateur stations in the Arctic but that my station has been the only one with whom they have been able to communicate, I consider this quite a record for "PARAGON APPARATUS" and am glad to be able to advise you how proud I am of my receiving apparatus.

Yours very truly,
Jack F. Barnsley.

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BAKELITE

$1.75

"And it's real bakelite!"

FROST RADIO

TUBE CONTROL UNIT

HERE'S the finest piece of radio apparatus of its kind you ever saw! The new **FROST-RADIO** Genuine Maroon BAKELITE Tube Control Unit combines the following:

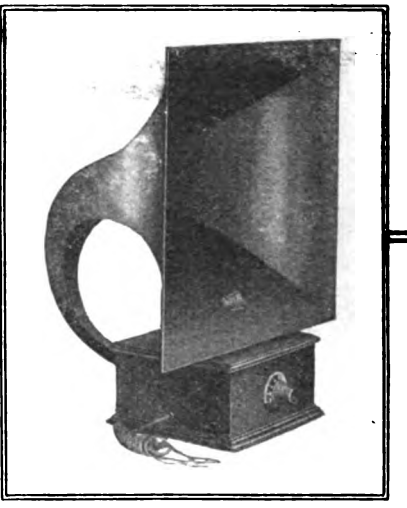
—a high grade 6 or 35 ohm vernier rheostat.
—a precision-built 400 ohm potentiometer.
—single hole mounting.
—smoothly working moving parts.
—superior design and finish.

When you install a **FROST-RADIO** Tube Control Unit on your set you end all tube control troubles—insure best results—save money. Either 6 or 35 ohm rheostat types: $1.75. All metal parts nickel plated and hand buffed.

Your dealer stocks FROST-RADIO

Go to your dealer today and examine this fine piece of apparatus. Judge for yourself if it is not the biggest value you ever saw. Your dealer also stocks **FROST-RADIO** Sockets, Dials, Adapters, Fones, Jacks, Plugs, etc.

HERBERT H. FROST, *Inc.*
New York CHICAGO Kansas City



CALLOPHONE $35.00

You Can Hear a Pin Drop!

During a pause in the program reproduced through the Callophone. No metallic vibration or "static" to mar your enjoyment. Any disturbance instantly cleared by a turn of the dial controlling the diaphragm.

The Callophone Radio loud speaker is the result of years of experience in making loud speaking commercial apparatus—recognized as the finest obtainable.

The Callophone is built throughout with careful attention to each detail, and tested under actual operating conditions before leaving the factory. No extra batteries or equipment are required.

Not sold by all Radio Dealers. Sent direct from our factory to you, upon receipt of the purchase price—which will be returned to you if, after a ten day trial, you do not find it all we claim.

Incidentally, every Callophone we send out STAYS. We don't expect it back, because it has been tested beside every make of loud speaker, and *none can compare.*

CALLOPHONE COMPANY OF NEW YORK, Inc.
216-222 Mercer Street
New York, N. Y.

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I Can Qualify You as a Radio Expert in a Few Months!

E. R. HAAS
Director of National Radio Institute

Learn at Home Earn $2500 to $10,000 a Year

Merle Wetzel, one of my students, reports that he now is making *three times* what he did before becoming a radio expert. Emmett Welch writes that after finishing my training he made $300 a month and all expenses. George Jones says: "To your course I credit my present position as manager of this Radio Department." Hundreds of other former students enthusiastically tell of their successes as radio experts! The field of Radio today is a real treasure house of wonderful opportunities. It offers rewards beyond your fondest dreams! Mail coupon today for Free Book just out—which explains in detail the amazing opportunities in this World's Fastest-Growing Industry.

Hundreds of Big Paying Positions Waiting

Do you want to earn far more money than you ever dreamed possible? Do you want to be your own boss—to have a profitable business of your own? Do you want to travel the whole world over—and make big money while doing so?

Radio offers you all of these opportunities—and more! Radio, the new infant industry; Radio, growing with leaps and bounds; Radio, the field of endeavor with the most promising future of all!

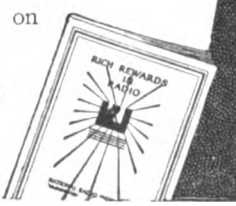
Never in all history has an industry jumped into prominence so rapidly! Millions of dollars were spent last year on Radio. Hundreds of big-money positions were created almost overnight. Thousands of men trained in Radio were needed. And the future holds even greater promise for those who enter this fascinating field. Learn more about what Radio can offer *you*. Send for our new FREE BOOK on Radio.

Pick Out the Job You Want We Will Help You Get It

This is a brief list of the positions in the Radio field today, and the salaries paid:

Broadcasting Station Operator, $125 to $250 a month.
Commercial Land Station Operator, $150 a month and up.
First-class Ship Operator. $105 a month in addition to all expenses paid.
Radio Engineer, up to $10,000 a year.
Radio Inspector, $1,800 to $4,500 a year.
Radio Salesman, $2,000 to $10,000 a year.
Radio Mechanic. $1,500 to $4,000 a year.
Radio Instructor, $150 to $250 a month.
Radio Draftsman, $7 to $10 per day.
Radio Executive, up to $15,000 a year.

NOTE: RADIO FIRMS Secure Practical Radio Experts Among Our Graduates Write Today.



This Wonderful FREE BOOK Has Shown Thousands the Way to Bigger Money

This Free Book has opened the eyes of thousands to the glorious opportunities in Radio. If *you* are ambitious—if you are looking for a field which offers *big money, fascinating work, advancement, and a real future*, send for this Free Book. It costs you nothing. You obligate yourself in no way. Yet this book can easily mean all the difference between the work you are doing now and wonderful success! Before you forget—mail the coupon NOW!

NATIONAL RADIO INSTITUTE
Dept. 32AB, Washington,D.C.

E. R. HASS
NATIONAL RADIO INSTITUTE
Dept. 32AB, Washington, D. C.

Without obligation on my part, please send me the free book, "Rich Rewards in Radio," with full details as to how I can quickly train for the position of "Certified Radio-trician" in my spare hours at home. Also tell me how your free Employment Service will help me secure a good-paying position, and about your special short-time offer. Please write plainly.

Name.....

Street.....

City.....State.....

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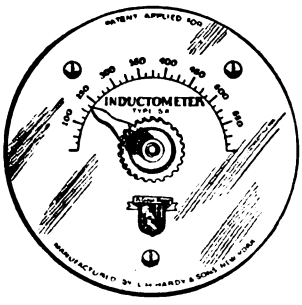
A Good Name



Hardy Circuit Inductometer

Patents Pending

Toroidal Transformer

2,500-mile type*.....$8. 50
1,500-mile type..... 3. 50
*** taps on sub-panel**

The Hardy Circuit utilizes a specially wound inductance by which the utmost sensitivity with selectivity is attained. A transformer ratio of from 4:1 to 8:1 is secured by the Hardy design.

We guarantee the operator 2,500-mile range using our improved $8.50 type of inductometer and over 1,500-mile range with $3.50 type. The first has a spider rotor, sub-panel tapping design and bank wound secondary. It is sold with panel indicator and knobs.

200-600 Meter Type*.....$5.00
3,300 Meter Type..... 9.50
*** without mounting case $2.15**

After many months of testing and experimentation, our research engineer has developed a Toroid Radio Frequency Transformer for use in Neutrodyne and Super-Heterodyne circuits.

The coils are so wound that there is a minimum of capacity in the windings and the lowest dielectric loss possible. The coupling is extremely high. The external field is so small that with two inch spacing it is possible to construct a very compact receiver without use of shields.

Write For Descriptive Literature

L. H. HARDY & SONS, Inc. 528 SIXTH AVENUE NEW YORK, N. Y.

MODEL NO 5014 Radio Frequency Amplifying Unit
MODEL NO 5013 DETECTOR UNIT
MODEL NO 5012 Audio Frequency Amplifying Unit

There's No Need to Experiment with Day-Fan Radio Units

For your safety, convenience and economy, you can now get Day-Fan Radio Units assembled into sets. One of these sets will exactly meet your wants. You need not waste time and money in trying to find out for yourself what you need to complete your outfit. See your dealer and he will suggest what Day-Fan type you should have. This will insure you better results, greater pleasure and real economy.

THE DAYTON FAN & MOTOR COMPANY :: Dayton, Ohio

Established 1889

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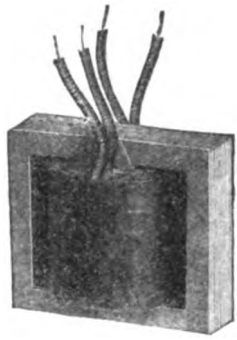
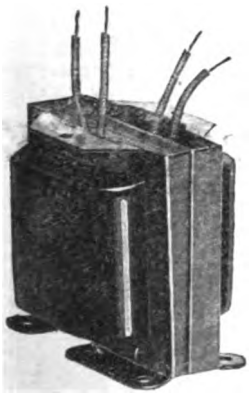
A Transformer of Real Merit

The winding that Kellogg developed, was found to be most efficient for audio frequency transformers. Its problems involved the finding of the proper thickness of paper, the proper kind of insulated wire to provide the proper number of ampere turns, and impedence.

Amplification of Entire Musical Range Free from Distortion



The one-piece laminations of silicon steel contain no punched holes, which in many other transformers causes eddy currents and losses. The one-piece lamination is exclusively a feature of the Kellogg transformer. It provides an exceptionally true electro-magnetic core.



To correctly shield these transformers that they may be mounted in any position desired without losses, this brass shield was designed. It is so arranged that both sides are interchangeable, locking together at the base. They are finished in a handsome maroon enamel.

The wires extend through the Bakelite top, which affords perfect insulation, and are soldered to the terminals in plain sight, where they may be inspected. This also eliminates any possibility of breakage of transformer leads.

The finished job, of which we are mighty proud. The leads are soldered to tinned terminals, which are under nickel plated nuts over which are placed knurled nuts. Each binding post is plainly marked so that it is impossible to make incorrect connections.

Amplify the pleasure of your radio set by installing Kellogg audio frequency transformers. Second to none in volume, clarity and freedom from distortion.

No. 501—Ratio 4½ to 1. No. 502—Ratio 3 to 1. Only $4.50 each

Built and Guaranteed by

Kellogg Switchboard & Supply Company

1066 West Adams Street, Chicago

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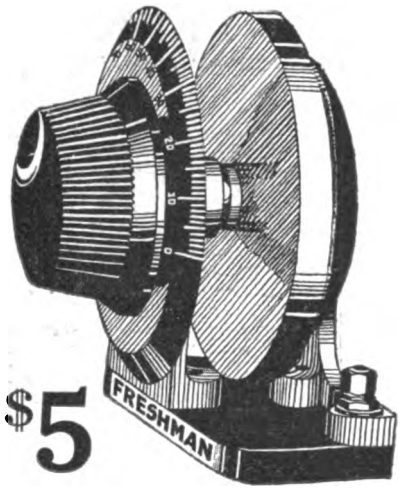
For Transmission or Reception!

"FRESHMAN SELECTIVE"
MERCURY VARIABLE CONDENSER



$5

It has been conceded by the Foremost Radio Engineers that a Variable Condenser with Mercury plates is the most efficient for fine adjustment and selective tuning. Our engineers, after exhaustive experiments and research work, have developed a Variable Condenser with Mercury plates separated by heavy Mica dielectric. It is the ONLY VARIABLE CONDENSER the plates of which actually vary in area—AN ENGINEERING FEAT NEVER ACCOMPLISHED BEFORE.

No leakage
Absolutely quiet
No plate vibration
Will stand 5000 volts
Compact and attractive
Plates cannot collect dirt
Cannot become short circuited

.0003 m. f. (equivalent to 17 plate)
.0005 m. f. (equivalent to 23 plate)
.001 m. f. (equivalent to 43 plate)
ALL TYPES **$5**

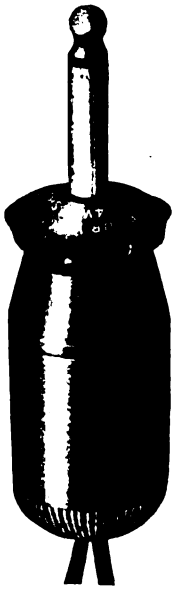
All Molded Parts and Dial of the Finest Bakelite

At your dealer, otherwise send purchase price and you will be supplied postpaid

Chas. Freshman Co. Inc.
Radio Condenser Products
106 SEVENTH AVE. NEW YORK

FOUR WAY CO.

New Model



"4-WAY" SWITCH PLUG : :

At Your Dealer's

$1.50

Switch on Loud Speaker or Head Phones by turning dial without removing Plug from Jack. Two Head Sets may be used if preferred or both Loud Speaker and Head Set AT THE SAME TIME

The new 1924 model "4-Way" Switch Plug embodies many improvements, making the manipulation much easier. The improved Spring Locking Terminal Connections are far superior to binding screws. They form permanent electrical contacts which never work loose, as binding posts are apt to do.

New SINGLE Radio Plug—
50c —*the finest yet produced*
—employing our positive spring terminal connections that have proved so successful in our FOUR WAY PLUG—never works loose.

See these beautiful plugs AT YOUR DEALERS

Manufactured by

FOUR WAY CO.
Myrick Bldg., Springfield, Mass.

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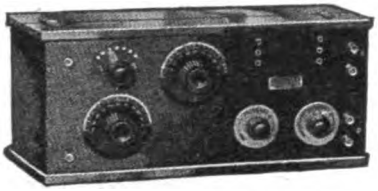
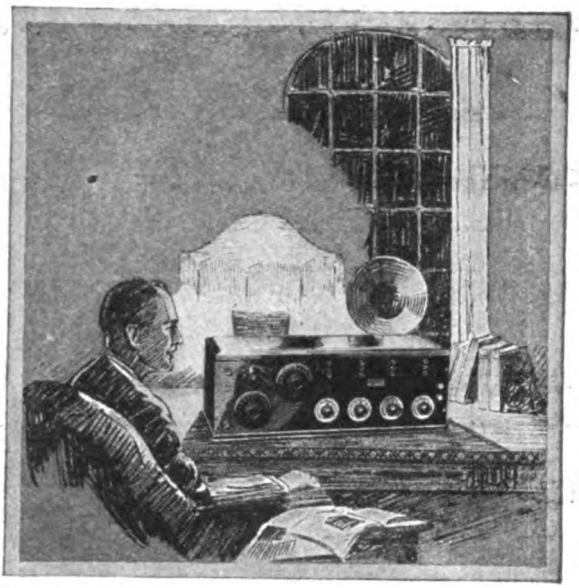


E·D·Elliott *of* Milford, N.Y. establishes a *record*

Think of getting London, England, Fairbanks, Alaska, and La Palma, Panama, when you live in New York! Yet this is the experience of Mr. Elliott, one of the hundreds of enthusiastic users of MIRACO sets. With the inexpensive outfit shown here, priced at **only $29.50**, he received the following list of stations—*results that would do credit to a set costing three or four times as much.*

	London, England	WHAY	Wilmington
WLAY	Fairbanks, Alaska	WRAY	Scranton, Pa.
NNW	La Palma, Panama	WOAY	Birmingham
PWY	Havana, Cuba	WSB	Atlanta, Ga.
CFAC	Calgary, Can.	WMU	Washington
CJCY	Calgary, Can.	WCAT	Rapid City
KFBC	San Diego, Cal.	WRC	Washington
KSL	San Francisco, Cal.	KYW	Chicago
KHQ	Seattle, Wash.	KFCB	Phoenix
WJAR	Providence, R. I.	WWT	Buffalo, N. Y.
KFBU	Lorine, Wyo.	WHAS	Louisville, Ky.
WEV	Houston, Tex.	WCAY	Milwaukee, Wis.
WMAT	Duluth, Minn.	WLW	Cincinnati, O.
WPM	Washington	WDAW	Omaha, Neb.
WRAA	Houston, Tex.	WOQ	Kansas City
WHB	Kansas, Neb.	WPAW	Wilmington
KFHB	Hood River, Ore.	WCE	Minneapolis
CFCA	Toronto, Can.	WCX	Detroit, Mich.
CKCE	Toronto, Can.	WLAZ	Warren, O.
CJCI	St. John, Can.	WAAS	Decatur, Ga.
WRP	Dallas, Tex.	WTAM	Cleveland, O.
NGE	Miami, Fla.	WWJ	Detroit, Mich.
KGA	Oakland, Cal.	WJAZ	Chicago, Ill.
KFEL	Denver, Colo.	WDAP	Chicago, Ill.
WIAZ	Miami, Fla.	WGY	Schenectady, N. Y.
WKY	Oklahoma City	WJZ	New York City
WDAE	Tampa, Fla.	WEAF	New York City
WEB	St. Louis	WOR	Newark, N. J.
WRK	Hamilton	WHAS	Louisville, Ky.
WHAB	Galveston, Tex.	WEAB	Dodge, La.
LZV	Salt Lake City	WKD	Gainville, Ga.
NAA	Arlington Va.	WUQ	Washington, D. C.
WJAX	Cleveland, O.	KMO	Tacoma, Wash.
WBZ	Springfield	KOB	New Mexico
WOO	Philadelphia, Pa.	WDAR	Philadelphia, Pa.
WOS	Jefferson City, Mo.	WFI	Philadelphia, Pa.
WOK	Pine Bluff, Ark.	WIP	Philadelphia, Pa.
WLAG	Minneapolis	KDKA	Pittsburg, Pa.
WFAZ	Charleston	WCAE	Pittsburg, Pa.
WJAB	Lincoln, Neb.	KMN	Butte, Mont.
WCT	Chicago	KQP	Hood River, Ore.
WMC	Memphis	WHAZ	Troy, N. Y.
WBAK	Harrisburg	WGR	Buffalo, N. Y.
WLAK	Bellow Falls, Vt.	WMAV	Auburn, Ala.
WBAN	Paterson, N. J.	KFDD	Boise, Ida.
WOC	Davenport	WNAL	Omaha, Neb.
WPAP	Winchester, Ky.	WCAP	Washington, D. C.
WMAM	Beaumont, Tex.	WQAB	Springfield, Mo.
WWZ	New York	WFB	St. Louis, Mo.
WBAY	New York	WDR	Detroit, Mich.
WGL	Philadelphia, Pa.	WNAC	Boston, Mass.
WMAF	Dartmouth, Mass.	WBAZ	Columbus, O.
WBAG	Bridgeport	CFZC	Montreal, Que.
WCAP	Decatur	WMAK	Lockport, N. Y.
WHN	Ridgewood	WGF	Des Moines, Ia.
WIAR	Paducah	WHAM	Rochester, N. Y.
WRP	Camden, N. Y.	WCAM	Villa Nova, Pa.
WGAR	Fort Smith, Ark.	WGAY	Madison, Wis.
WDAK	Hartford, Mass.	WWI	Dearborn, Mich
WCAG	New Orleans	WGAM	Orangeburg, S. C.
	WWAJ	Columbus, O.	



Radio's finest low-priced receivers

Here, in the improved MIRACOS, you'll find the same thrill of getting long distances, generally obtainable with only the most expensive and elaborate sets. To the whole family it will furnish entertainment, **unfailingly**, the whole year round—and at an initial price most every family can afford.

It isn't necessary, either, to be an expert at tuning in with the MIRACO. The operation is extremely simple. Scores of users everywhere tell us of the long-distance records they're making—Cincinnati hears 'Frisco, Denver hears Schenectady, New York hears Havana!

Such range as this is made possible through MIRACO'S many new refinements. Improved rheostats with multiple resistance windings enable you to use any type of tube, and a new aluminum shield prevents annoying body capacity effects. Shock absorbing pads prevent tube noises. Fully GUARANTEED against defects in material or workmanship. Price for 4-tube outfit shown above only **$54.50.**

Other details of MIRACO receivers are explained more fully in our new bulletin. Write today for a copy.

THE MIDWEST RADIO COMPANY
812 Main Street, Cincinnati, Ohio

The Improved MIRACO

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Clear as a Silver Bell

The O-T is the only genuine Silvertone Tube. Fully guaranteed. Beware of imitations.

O-T SILVERTONE TUBES
(Registered)

will increase the signal strength of your set from 20 to 50 percent—even to a greater degree when used as a NEUTRODYNE detector.

Three Models

O. T. 1A—2 to 4 volts, Battery Draw .15 amps. Price, $6.00

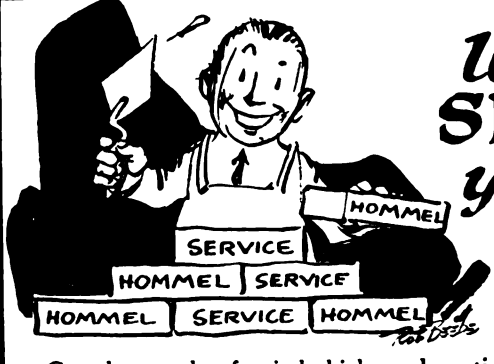
O. T. 9—2 to 4 volts, Battery Draw .06 amps. Price, $6.50

O. T. Power Tube—5 volts, Battery Draw .25 to .35 amps. Price, $7.50

At your dealer or direct by mail. Write for complete literature.

Manufactured by DeForest Tel. & Tel. Co.
Exclusively for the
O. & T. Electric Corporation
1819 Broadway, New York
High class representatives wanted.

Use HOMMEL SERVICE to build your radio business



Complete stocks of strictly high grade nationally advertised radio apparatus are constantly carried by this Company to enable you to build your radio business on the right foundation. Your success is dependent largely on the products you sell, and your ability to serve your customers promptly.

Aligning yourself with the HOMMEL organization makes it possible for you to always have access to ample stocks of the leading lines of radio equipment without the necessity of tying up your working capital.

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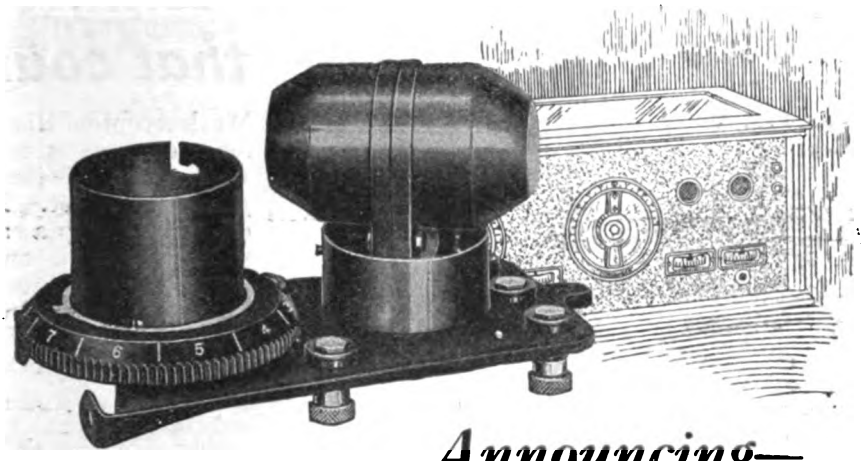
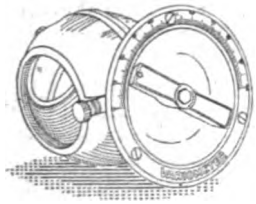
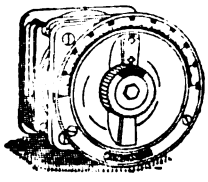
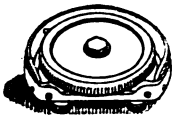


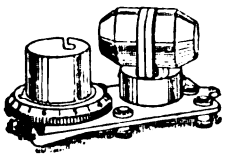
Announcing—

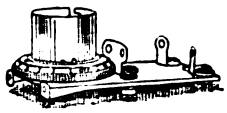
A New Radio Frequency Transformer











—in a combination unit, consisting of transformer, tube socket and rheostat.

Especially designed for use in tuned radio frequency circuits—the most practical method of amplifying high (radio) frequency impulses.

The trend toward radio frequency amplification is to be expected. Its advantages are many—long distance reception; the excellent results obtained with indoor aerials, and an entire absence of interference with neighboring receivers.

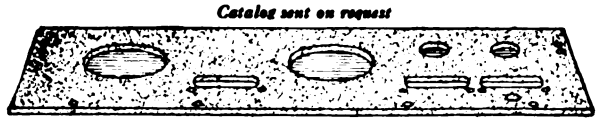
When incorporated in a tuned radio frequency circuit, this transformer amplifies efficiently at all wave lengths employed in present-day broadcasting.

All Eisemann units are matched one to the other, not only in their electrical co-relation but also in appearance, and, when assembled, present a harmonious whole.

Complete instructions for wiring are given, and the individual not deeply versed in Radio can build a receiver with assurance of results.

EISEMANN

Catalog sent on request



EISEMANN MAGNETO CORPORATION

WILLIAM N. SHAW, *President*

46 Thirty-Third Street **Brooklyn, N. Y.**

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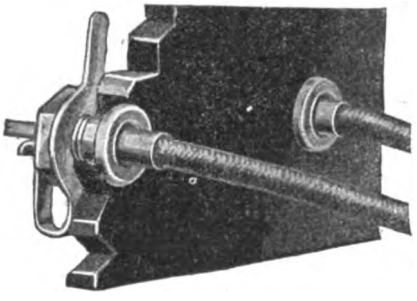

Union Radio Tip Jacks

(Patent Pending)

Price 25c

Just what you want when building your own set or experimenting with new hook ups. Not only give positive electrical contact, they improve the appearance of your set.

Two sizes for all mountings. **Standard Type A** for panels up to ¼ inch thickness, **Special Type B** for panels, cabinet walls and partitions from $\frac{5}{16}$ to ½ inch thickness. Will firmly grip all wires from No. 11 to 24 B. & S. gauge, and can be reamed to pass and hold antenna wire, battery leads, loading coils and vacuum tube lugs.

No parts to lose, chip or deteriorate. All parts heavily nickeled. **Price 25c**

Other Guaranteed Union Radio Parts

Dial adjusters for minute variations in capacities of variable condensers. **Price 60c**

Tube sockets of molded condensite highly polished. Phosphor Bronze contact springs. Reinforced bayonet slot prevents breakage. Accommodates all standard tubes. **Price 70c**

Should your favorite Radio Store not carry Union Radio Tip Jacks and Guaranteed Parts send your order direct to us, also write for your copy of "The Union Radio Catalogue 'A.'"

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Samples of our guaranteed, reasonably priced "Quality Products" sent on request. Our terms and trade discounts are liberal. Write for our proposition.

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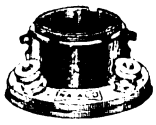
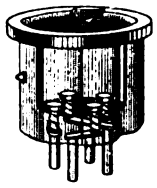
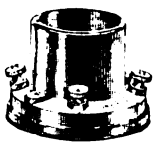
It's the contact that counts



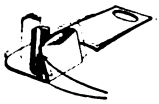
Na-ald Special Socket No. 499 for UV-199 and C-299 Tubes. Price 50c



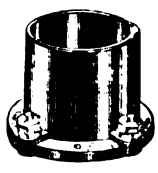
Na-ald Adapter No. 429 for UV-199 and C-299 Tubes. Price 75c



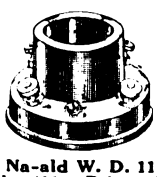
De Luxe No. 400 Price 75c



De Luxe Contact



Small Space No. 401 35c, 3 for $1.00



Na-ald W. D. 11 No. 411. Price 75c

Weak reception due to inferior contacts is banished when Na-ald sockets are placed in a set. Na-ald contacts exert a strong, wiping pressure on tube prongs over a broad surface, regardless of frequent removal of bulbs or variation in the length of prongs.

You can count on Na-ald sockets under all conditions. They are moulded of genuine Bakelite, with uniform cross-section and cure. These features prevent plate-to-grid losses and insure full efficiency from tubes.

Insist on Na-ald sockets and put an end to weak reception. All good dealers carry them.

NA-ALD INSIDE INFORMATION

(No. 429)

Have you realized that the matter of design in anything as simple as an adapter will make a big difference in the results obtained with a U. V. 199 or C 299 tube? Na-ald No. 429 Adapter makes it possible to use these excellent tubes in regular standard sockets. Not only must means be provided for holding the tube, but had we used flat springs or allowed broad flat surfaces to run parallel in this adapter, the capacity would rob this tube of much of its effectiveness. Again, full-surface, positive contacts were necessary. These are provided by plunger pads backed with music wire springs pressing against metal cross-overs moulded in solid Bakelite. Na-ald adapters cost but 75c, a very reasonable price in view of their assurance of the highest tube efficiency.

Write for "why a Bakelite Socket" and other descriptive literature

Alden Manufacturing Company

Largest Makers of Radio Sockets and Dials in the World—Why?

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NA-ALD

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Standard equipment on the better sets

ALL-AMERICAN

Amplifying TRANSFORMERS

For "Push-Pull" Circuits: The All-American Power Amplifying Transformers. Input and Output types.

$6.00 each

for utmost volume and pure rich tone —add Power Amplification

The addition of the well-known "Push-Pull" form of amplification to your audio frequency amplifier—by means of All-American Power Amplifying Transformers—will develop maximum volume with a roundness, richness, depth and purity of tone that will delight you. Use any good loud-speaker.

All-American Power Amplifiers have been conclusively proved the most efficient, most satisfactory "push-pull transformers that have ever been made. Here, too, All-Americans lead the industry.

SPECIAL OFFER!

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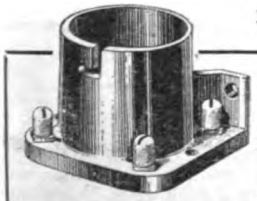
Pioneers in the Industry



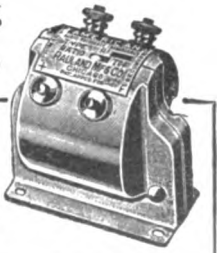
All-American Socket

One-piece molded bakelite—for panel or base mounting. Finest socket money can buy. Only 75c.

All the better dealers sell the All-American

All-American Audio

Frequency transformers. Three ratios: 3:1, 5:1, 10:1. Prices: $4.50, $4.75, $4.75. The best—no need to pay more.



More Than 500,000 Satisfied Users

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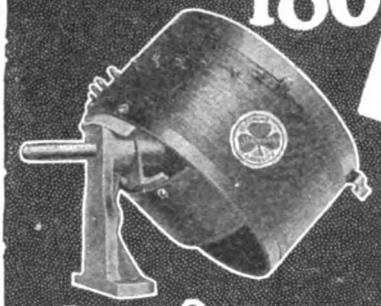
FOR SELECTIVE TUNING

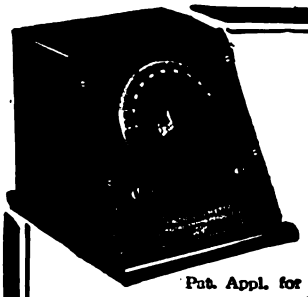
180° Vario-Coupler

list price,
$3.50 *each*



DOUBLE DUTY PIG-TAIL Variometer

SHAMROCK MFG. CO.
314 E. Market St. — Newark N. J.



Pat. Appl. for

— one at a time
with a
CONTROL-O-METER

You can *select* the programs you want to hear if you equip your set with a Control-o-meter, and you don't need technical knowledge to get results. Just turn the dial to a number indicated on the individually calibrated chart supplied with each Control-o-meter and the interfering program disappears.

THAT'S ALL THERE IS TO IT

No matter what kind of a set or antenna you have or where you live, the Control-o-meter will allow the reception of one program without interference from another. Moreover, the addition of a Control-o-meter will not decrease the volume of distant stations.

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We are putting forth every effort to make the Control-o-meter easy to get through local dealers; but should you be unable to secure a Control-o-meter, we will ship you one postpaid on receipt of price.

$12.50

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and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete tube set having a range of 500 miles and more, including tube, head set, batteries, and antenna equipment, as low as $23.50.

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Just a few hours each week of pleasant home study trains you in amazingly short time. Make your spare time earn you cash. We show you how. Many are earning from $3,000 to $10,000 a year.

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The Branston-Quality-Guaranteed Audio-Transformer

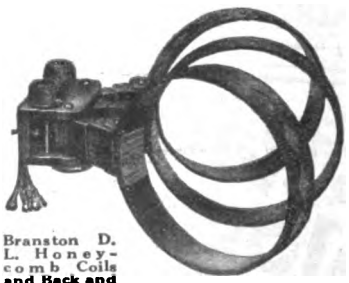
YOU can *now* get rid of noisy or otherwise unsatisfactory transformers and, with perfect confidence, replace them with this fully-tested-and-proved audio frequency transformer. The results will delight you and your "audiences."

You can *now* make up new sets, with the certainty that you have the maximum-possible amplification and best tone quality without distortion.

If your dealer has not yet secured his supply, send check or money order for as many as you need, @ $6.50 each, or order parcel post C.O.D. Mention your dealer's name, please.

Branston Quality Guaranteed Audio Frequency Transformer. Neat, compact, efficient. It gives the results you want. Each $6.50

Use Branston "Broadcast Coils" for Closer Selectivity



Branston D. L. Honeycomb Coils and Back and Front Geared Mountings are "Standard of the World"

Very fine adjustment, close selectivity and clearer reception for all wave lengths between 250 and 600 meters. Wound on Formica Tubes 5" diameter. Equipped with standard coil plugs. Fit any Honeycomb coil mounting. Furnished only in sets of three, Primary, Secondary, Tickler. In attractive carton, per set, at dealer's or by mail..... $5.00

Look for this trade-mark card in your dealer's window or salesroom

Send 2c Stamp for New Honeycomb Coil Hookups

Compiled by experts and includes five good Honeycomb Coil "Hookups" and complete catalog of famous Branston Radio Apparatus. Write today. Give us name of your radio dealer. If he cannot supply you, write —

CHAS. A. BRANSTON, Inc.
Manufacturers of Branston Violet Ray High Frequency Generators
811 Main St., Buffalo, N. Y.
In Canada—Chas. A. Branston, Ltd., Toronto

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"New York's Grand Opera – one of the many events enjoyed by Magnavox owners"

MAGNAVOX
Radio
Reproducers and Amplifiers

MAGNAVOX instruments are never subject to those internal interferences which, at critical moments, are so apt to mar the performance of ordinary radio reproducers.

To measure the success which Magnavox engineers have accomplished in the design and manufacture of Magnavox products, remember that they have been sold in far larger quantities than any other radio units in the world.

Magnavox Reproducer

R2 with 18-inch curvex horn $60.00

R3 with 14-inch curvex horn $35.00

M1 with 14-inch curvex horn. Requires no battery for the field $35.00

Magnavox Combination Sets

A1-R consisting of electro-dynamic Reproducer with 14-in. curvex horn and 1 stage of amplification . $59.00

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A1—1-stage . . . $27.50

AC-2-C—2-stage . $55.00

AC-3-C—3-stage . $75.00

Magnavox Products are for sale at Registered Magnavox Dealers everywhere. Write for new 32-page Magnavox Radio Catalogue.

THE MAGNAVOX CO., Oakland, California
New York Office: 370 Seventh Avenue
Perkins Electric, Limited, Toronto, Montreal, Winnipeg
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2R

For every receiving set there is a MAGNAVOX

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A Vernier Condenser

A Grid Control

Every Detector Tube Needs

a Vari-Grid

Tube characteristics are not alike. The Vari-Grid varies the capacity of the tube. Has variable grid leak. Also used as a plate condenser. 1¾" wide, one hole to drill.

If your dealer cannot supply you, order direct. **$2.25**

Write for Booklet

RANDEL WIRELESS COMPANY
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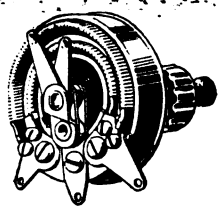


HERE IT IS!

Two Rheostats in One

PREMIER

"DUOSTAT"

Trade Mark

You will see the advantages of this remarkable new apparatus at once. A real innovation. Think of it! One high-class Rheostat that completely replaces two of the ordinary types; does the work even more efficiently, and, in addition, greatly simplifies installation and wiring. One hole to drill, THAT'S ALL. That's what you get in the "Duostat."

Two independent resistor windings, each operating one tube. Bakelite Moulded Base, silver etched dial, "NICHROME" wire windings. Made for all types of tubes. No. 12, two windings, each 7 ohms. No. 13, two windings, each 25 ohms. No. 14, two windings, each 40 ohms. Price all types, $3.00.

You can't afford to leave out the "DUOSTAT" in your next "hook-up." Send for our free Bulletin No. 92.

ASK YOUR DEALER

Price $3.00

Complete with silver etched dial, knob, pointer, etc.

Premier Electric Company
3807 Ravenswood Ave. CHICAGO, ILL.

Approved!

180° Straight Coupler #56

A Real FISCHER Instrument

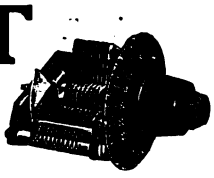
Wave length 550 meters, 14 soldered leads, straight wound stator on genuine bakelite tubing, bakelite rotor, Fahnestock spring clip connections, white metal mounting base, non-conductive adhesive,—in short a perfect coupler.

20 Diagrams $2.75 Free with Each

For sale at your dealer's—otherwise send $2.75 directly to the manufacturer and you will be supplied postpaid.

G. H. FISCHER & CO.
123 Liberty Street New York City

B-T



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in 1924 as in 1921

B-T products are originals, not copies—not built just to sell—but to give satisfaction.

Better Tuning B-T

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Price 10c

It is our aim to please you more with the product itself than by what we say about it—

Our latest booklet will help you. It is revised each month.

Sent for 4c postage.

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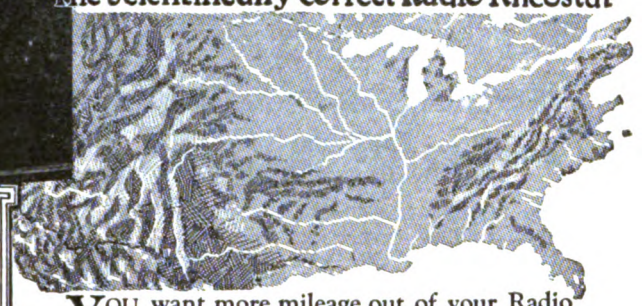
Get more Mileage out of your Radio Receiver

With THE FILAMENT KONTROL OF INFINITE ADJUSTMENT

FIL-KO-STAT

The Scientifically Correct Radio Rheostat



From RICHARD J DAVIS
700 East Erie St., Painsville, Ohio
"FIL-KO-STAT cannot be beat for fine adjustment and noiseless operation. The first night after installing it I got KDZA, Tuscon, Arizona (1500 miles), KYY, San Francisco (2500 miles) and WHA, Madison, Wis., (1000 miles)—all came in clear and loud * * * without FIL-KO-STAT never have picked up these stations."

From LESLIE C. BILES
Maple and Burlington Aves., Delanco, N J
"After experiments with various filament controls, I have adopted FIL-KO-STAT as the finest instrument for ***controlling detector** In my humble opinion it is the greatest Radio Achievement of the year ****stations never heard before**(include) WOAO, WDAF, WCX, WOC. WSB, and WLAG on loud speaker On Oct 28th, at 8 P M with powerful Philadelphia stations operating I tuned in with FIL-KO-STAT WKAQ, San Juan, Porto Rico **do not feel that I can say enough in praise of this little instrument** Many sets that are inclined to tune broadly can be improved with FIL-KO-STAT It will positively separate stations on close wave lengths."

From H. R. HASLAM
249 W 126th St., New York, N Y
"**Three tube standard set**wire wound rheostats gave satisfaction on local stations, but on distant reception could not get point between owing to coarseness of adjustment With FIL-KO-STAT change was wonderful, getting distant stations never received before, even Oklahoma City quite strong despite local interference."

From JACK WALSH
Independence, Colorado
"FIL-KO-STAT certainly a wonder Following stations received in nine days on one bulb WOAW, WDAF WFAA, WJAZ, WOC, WBAP, WHB, KFI, KHJ, KFEL, KFIX, WSB, WMC, KLZ, KFFO, WWAC, KZN, WDA, WLAG, WDAP, WGY (2000 miles) CKCK, WOS, KOP, CFCN, WDAE, KSD, WJAD, WCBD, KDYL, WHAS, KDKA, KGW, WAAW, KFKB, KGW, WEAY, WOI, KOB I believe the FIL-KO-STAT is the secret of my success.

You, too, will be writing letters like these when you have tried a Fil-KO-Stat in your set

Radio News Laboratories say:

This filament rheostat (Fil-KO-Stat) is designed to control the filament current of practically all types of receiving tubes now on the market. It is noted for its exceptionally infinitesimal and uniform control of the current.

For instance, the critical adjustment of a one-ampere tube is spread out over a range of four turns of the knob, thus enabling a micrometer adjustment to be obtained.

APPROVED RADIO NEWS LABORATORIES 1922

RADIO STORES CORPORATION
Sole International Distributors
NEW YORK — CHICAGO — MINNEAPOLIS — LOS ANGELES — CLEVELAND — ST. LOUIS — OMAHA — SAN FRANCISCO
HOME OFFICE, Dept. PR2, 226 West 34th Street, NEW YORK, N. Y

YOU want more mileage out of your Radio Receiver. You can't properly tune in distant stations. You want to clear up those tube noises so exasperating when a DX announcer is telling you who he is and all you get is, "This is station brbrweeizgrump". Yes, you get many distant stations *but you never hear them.* They're on your antenna, weak little brothers waiting to be magnified into audibility. They're there with song and story, concert and dance. How you do wish you could hear them! Condensers and couplers are all on the job, properly adjusted, but all you get are whistles and disappointments, BECAUSE:

Unless your RHEOSTAT is a FIL-KO-STAT you can't adjust the most delicate, most critical tuning unit on your set—and that's your *vacuum tube.*

Wave length isn't everything. There's a finer control needed. You must be able to make most minute adjustment of your filament heat and so control the electronic flow in the tube. When you do this you will have perfect reception free of all tube noises and YOU WILL HEAR DX STATIONS YOU NEVER HEARD BEFORE!!!

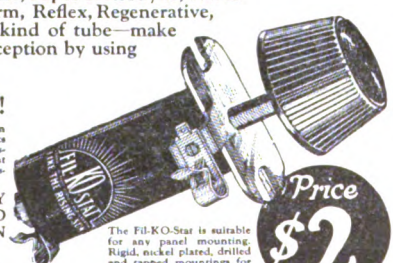
Regardless of what set you have, it will *pay you* in added pleasure and satisfaction to replace your present rheostat with a FIL-KO-STAT. It's so easy to make the change. Or have your dealer do it. And if you are building a new set, Neutrodyne, Super Hetrodyne, Radio Frequency, Phusiform, Reflex, Regenerative, *any* type with *any* kind of tube—make sure of complete reception by using FIL-KO-STAT.

IMPORTANT!

FIL-KO-STAT is not a carbon powder rheostat. Nor has it discs (which break and chip). Its resistance element is over 70 per cent metallic substances. Its full resistance is 30 ohms. And it is

UNCONDITIONALLY GUARANTEED TO GIVE SATISFACTION

BY THE DX INSTRUMENT CO.



The Fil-KO-Stat is suitable for any panel mounting. Rigid, nickel plated, drilled and tapped mountings for setting up Fil-KO-Stat on table, 15 cents additional.

Price $2

In Canada—$2.75

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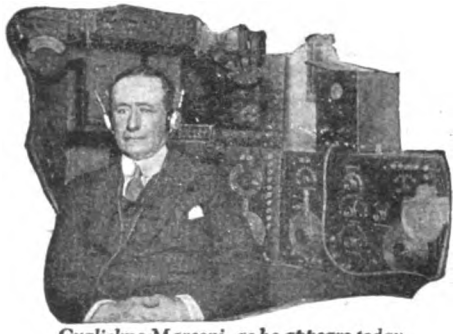

Guglielmo Marconi, as he appears today. Signor Marconi is Honorary Chairman of the Radio Institute of America

Write for information today

Success for You —in RADIO

The big men in radio today started—almost all of them—as radio operators. Very many of them are graduates of the Radio Institute (or Marconi Institute, as it was formerly called).

The demand for trained radio men today is too great to fill. Beginners are needed—and positions are open all the way up the ladder to the top. Train now. Radio is swiftly growing. And the opportunities grow with it.

Study at home

You can start now—at home—from the very beginnings of electricity—with the same guidance and instruction that has built the reputation of the Radio Institute. In a few months you can be fitted for your Government operator's license—and your first job.

The Radio Institute is under the auspices of the Radio Corporation of America, which places more men in radio than any other organization in the world—and gives preference to our graduates. Your opportunity is limited only by your ability.

Radio Institute of America

(*Formerly Marconi Institute*)
Established 1909

322A Broadway, New York City

Indicate by a cross X the course you are interested in:

Radio Institute of America,
322A Broadway, New York.

Please send me full information about radio opportunities today, and your *Complete Radio Course.*

Name.....

Address .....

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Morrison

Loud Speaker

Enthusiastic

—is the only word that describes those radio critics who have chosen Morrison Loud Speaker. For them Radio has taken on new delights. Bright stars of the musical comedy stage, famous lecturers and singers all are theirs no matter where they live—every night as long as they care to stay awake.

Real reproduction without annoying vibrations as soft or loud as you please—that describes Morrison attached to your phonograph tone arm or used with a horn.

$10.00

That's all Morrison costs complete with 5 foot cord Nickel Plated Model

This perfect little loud speaker has no rivals. We assure you your money back if you don't like it.

Ask for descriptive 2 color catalogue

DEALERS

Thousands of new radio fans have receiving sets—Christmas presents. Every one needs a Morrison Loud Speaker. We will show you how to merchandise Morrison. Ask us for our plan—at once.

MORRISON LABORATORIES, INC.

345 Jefferson Avenue East Detroit, Mich.

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ANCIENT ROME

THE far-flung conquests of Caesar's legions brought vast territories under the sway of Rome but crude methods of conveying information weakened the structure, and the empire fell.

To-day, due to Radio, the most remote settlement is in constant touch with the culture and events of the world. Geographical barriers have disappeared, and man's horizon is unlimited. Sensitive instruments developed through painstaking care and years of experimentation have made this possible.

The Holtzer-Cabot Company, out of its twenty-five years' experience, has developed a family of superior receiving units. They bring the world to your home.

Holtzer-Cabot Loud Speaker, $25.00
Loud Speaker Phonograph attachment, 10.00
No. 2 Universal Head Phones, 9.50
No. 4 National Head Phones, 6.00

Write for booklets explaining how the exclusive features of these instruments enable you to enjoy the wonders of Radio

THE HOLTZER-CABOT ELECTRIC CO.
125 Amory Street, **Boston, Mass.**
6161-65 South State Street, **Chicago, Ill.**
Department B

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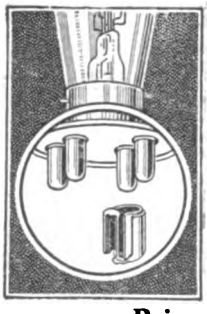
FLASH!

Another tube gone — "B" battery wires crossed for only an instant. RADECO Fuses would have saved it — they are saving thousands of tubes for satisfied radio fans. Read this letter ☞



Radeco
Safety Fuses

may be attached in an instant to any standard tube going in any standard socket.

In ordering, specify type of tube used

Price 50c each
At your dealer's or by mail postpaid

Radio Equipment Co.
Dept.2 **20 Stuart Street, Boston, Mass.**
New England's Oldest Exclusive Radio House
DEALERS: Write for our proposition

1358 Washington Street
West Newton, Mass.

RADIO EQUIPMENT CO.
20 Stuart Street, Boston

GENTLEMEN:

I am writing to give you an experience which I recently had which may be of interest to you.

I am a radio fan, and have experimented with many types of hook-up, I have also had the unfortunate experience of "blowing" several Radio tubes. Recently a friend of mine recommended your fuses, and I purchased three for my three-tube set which I am now using. Shortly after installing these fuses, in attempting to tighten a loose connection, my screw-driver accidently touched the "B" battery lead. All three fuses were blown and I realized that if it had not been for the Radeco Fuses I would have lost all the tubes in my set. I am inclosing herewith $3.00 for which please send me six fuses for UV201A tubes, as I do not wish to be without them. You are at liberty to use this letter in any way.

Very truly yours,
FRANK J. BODAY.

Build a beautiful long distance set— *for much less money!*

There is no thrill like the thrill you get from a set of your own creation. No joints to solder, no tools required, when you use R P M Standardized Units. Merely connect binding posts. Each R P M Unit is complete in itself. Moulded Bakelite—extremely beautiful. R P M Units are efficient in performance, superior in quality and *have absolutely no body capacity.* You can pay more but you can't buy better units. *Hook-up circuits in every package.*

This is the No. 102 R P M Mounted Variometer. Bakelite panel. A great performer. **$8**

R P M instruments—being standardized—permit changes in hook-ups enabling you to try different circuits by merely rearranging units. You can start with a few R P M's Units and add additional units as desired. Twenty years' manufacturing experience and latest machinery make possible these low prices. Ask your dealer—or write us. **Unconditional Guarantee.**

RPM

A UNIT FOR EVERY RECEIVING PURPOSE. MOUNTED AND UNMOUNTED VARIOMETERS, VARIOCOUPLERS, VARIABLE CONDENSERS, COUPLED CIRCUIT TUNERS, ALSO DETECTOR AND AMPLIFYING UNITS.

RADIO PRODUCTS MFG. CO.
667 W. 14th St., Chicago

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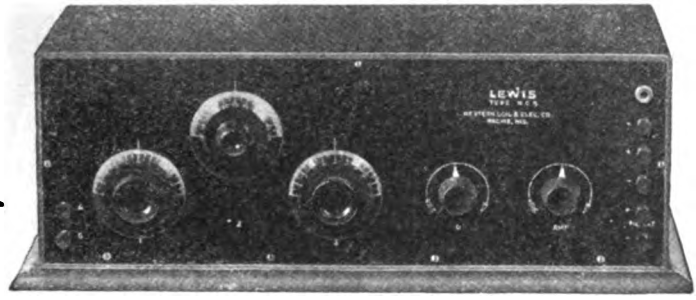

Are You Having Trouble Getting Short Wave Signals?

The WC-5-SW shown above picks up signals on wave lengths from 90 to 380 meters sharp and clear. It is the most practical set for low wave specialists. Built by short wave experts the WC-5-SW eliminates the trouble which transmitting amateurs are having with ordinary receiving sets. If you are interested in getting better results it will be to your advantage to investigate the WC-5-SW. Enthusiastic operators from all parts of the country write us praising its efficiency.

WC-5-SW

Built Especially for Transmitting Amateurs

The WC-5-SW is a 4 tube set. One stage of tuned Radio Frequency amplification is employed ahead of the detector to make it super-sensitive. Two stages of audio frequency are used to bring up the signal strength. Uses any type of tubes. Gives perfect control of audibility. Detector rectifies only. Uses antenna compensating condenser. Only two control adjustments. Pure negative biasing on all tubes, thus marked saving on B Battery current. Tuned Radio Frequency sharpest known and most selective principle ever adopted. Plate potential non-critical. Mono-block tube socket. No grid plate leads on audio amplifiers. Audio amplification absolutely necessary when using low efficiency receiving antenna, i.e., underground or indoor. Mahogany cabinet, piano rub finish. Rabbited-in panel. Split lid cover. The price is $85.00.

Write for complete description and illustrated folder on this practical set for low wave specialists. All transmitting amateurs will be interested in this literature.

OTT RADIO, Inc.

222 Main Street **La Crosse, Wis.**

TOT

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"Knowing radio batteries as I do, I consider yours most remarkable"—a statement made by one of the most prominent radio engineers. That is why engineers, manufacturers, amateurs and the public at large prefer Burgess Radio Batteries.

A Laboratory Product

BURGESS BATTERIES

"ASK ANY RADIO ENGINEER"

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The De Forest Audion

is commended on Jack Binns' Radio Page of the New York Tribune as "an excellent tube around which to build a set." Such expert endorsement and the satisfaction of thousands of users of De Forest Audions is what you naturally expect from this product. Remember that De Forest invented the three-electrode vacuum tube which makes all present-day radio possible.

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Dept. P. R. 6, Jersey City, N. J.

Use De Forest Audions

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Complete
Your
Radio
Outfit

Bring out the Best in your Receiving Set with a Bristol

TRADE MARK
AUDIOPHONE
REG. U. S. PAT. OFFICE
LOUD SPEAKER

It took six years to develop and perfect the Audiophone. That is more time than the average person cares to spend on a Loud Speaker for his receiving set.

But here it is, all ready for you to use by simply connecting to the set.

No auxiliary batteries are necessary.

The tone is big, full, and rich, and without that scratchy, tinny noise so often heard in receiving. It can easily be heard all through the house, so that your own family and friends can enjoy it with you.

The finish is a beautiful dull gold bronze.

Made in three sizes—

Senior Audiophone ..... **Price $32.50**
Junior Audiophone ..... **Price 22.50**
Baby Audiophone ..... **Price 12.50**

When signals are not sufficiently loud to give good results with the loud speaker, Bristol One Stage Power Amplifier is recommended to build up the power so that it can be heard even in a large hall ..... **Price $25.00**

Ask for Bulletin Nos. 3006 and 3011-L

THE BRISTOL COMPANY, Waterbury, Conn.

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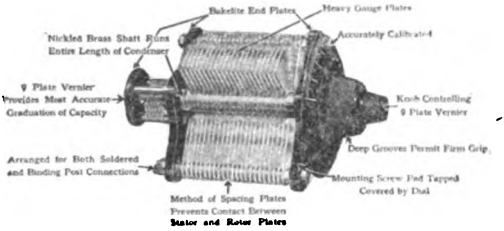
CHELTEN QUALITY RADIO PRODUCTS

THE LATEST IN CONDENSERS


Bakelite End Plates
Heavy Gauge Plates
Nickled Brass Shaft Runs Entire Length of Condenser
Accurately Calibrated
9 Plate Vernier Provides Most Accurate Graduation of Capacity
Knob Controlling 9 Plate Vernier
Arranged for Both Soldered and Binding Post Connections
Deep Grooves Permit Firm Grip
Mounting Screw End Tapped Covered by Dial
Method of Spacing Plates Prevents Contact Between Stator and Rotor Plates

THE CHELTEN RADIOSCOPE

Accurately spaced heavy gauged plates mounted between Bakelite ends, a special Chelten 9 Plate Vernier, and many other improvements make the Chelten RADIOSCOPE stand out as one of the most selective and satisfactory Variable Condensers money can buy. The 9 plate Vernier will susprise you with its unusual selectivity. You'll find stations you never imagined your set could receive. Made in 45 and 23 Plate type.

Chelten Midget Vernier

Can be used as a Vernier with any variable condenser. Its 13 plates make possible unusually fine graduation of capacity. Will increase the efficiency of all of the better circuits. Costs but $1.50.

Chelten Microfarad Jr.

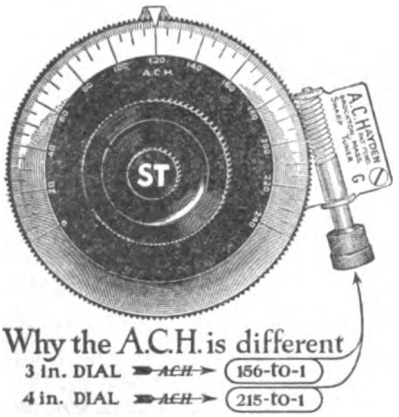
Specially designed as a Neutralizing Condenser of Low Capacity. Has 9 plates. A turn of the knob changes the adjustment without body capacity effect. Absolutely retains adjustment. Price but $1.75.

Send for Complete Catalogue of other Radio Products

CHELTEN ELECTRIC COMPANY

4861 Stenton Avenue :: :: Philadelphia

A Pleasant Surprise Awaits the User of the A C H Sharp Tuner Dials



Rough tuning or 1,000th of an inch in either direction.

Can be installed and will improve any receiving set, making difficult tuning easy.

Price 3-inch size **$2.50**
Price 4-inch size **$5.00**
Regular fitting 5/16 shaft ¼ and 3/16 ..... **5c** each extra

Money Back Guarantee

The principle of the A C H Sharp Tuner has only been embodied on very expensive instruments where the most delicate adjustment is necessary, and then as a permanent part.

Extra Advantage of the A C H

1. Can be attached or removed from any instrument.
2. Rough tuning same as any dial.
3. Movement so fine that the eye cannot detect but the ear can.
4. Automatically locks instrument so no jar can disturb it.
5. Dial grounded reducing the body capacity to a minimum.
6. Special dial 2 graduations where ordinarily one.

Mail Orders Sent Prepaid in U. S. A.

A. C. HAYDEN RADIO & RESEARCH CO.

Brockton, Mass., U. S. A.

Sold by Radio, Ltd., Montreal, Can.

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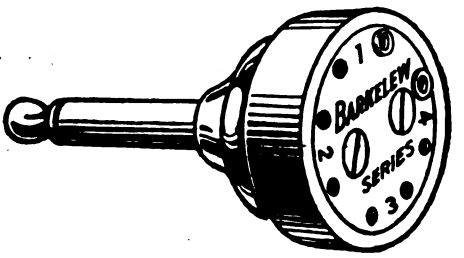
Barkelew Four-Phone Plug

PATENTS PENDING

Connects four phones or less in series to any Radio Set employing standard telephone jacks



Cat. No. 616
Price $1.50

It adds to the appearance of any set. With all phone tips adjusted, the diameter is but 1¼ inches

BARKELEW
ELECTRIC MANUFACTURING CO.
MIDDLETOWN, OHIO.

SAN FRANCISCO.
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Every Question ANSWERED for only $1

At last you have under one cover a Complete Radio Handbook

JUST OUT
514 PAGES

Compiled by
HARRY F. DART, B.S.E.E.

Formerly with the Western Electric Co., and U. S. Army Instructor of Radio.

Technically Edited by **F. H. DOANE**

NO more need you turn from book to book, hoping to find what you want. It is all here, in 514 pages crammed full of every possible radio detail. Written in plain language, by engineers for laymen. Clears up the mysteries, tells you what you want to know. A complete index puts everything within your reach in a few seconds.

IT EXPLAINS: Electrical terms and circuits, antennas, batteries, generators and motors, electron (vacuum) tubes, every receiving hook-up, radio and audio frequency amplification, broadcast and commercial transmitters and receivers, super-regeneration, codes, license rules. Many other features.

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Send $1 to-day and get this 514-page I. C. S. Radio Handbook—the biggest value in radio to-day. Money back if not satisfied.

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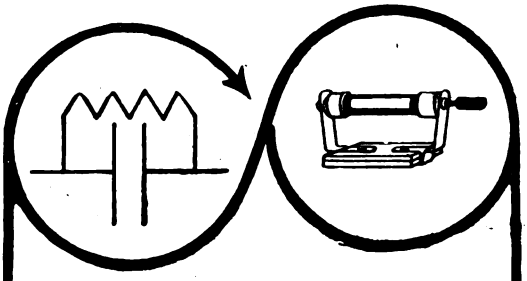
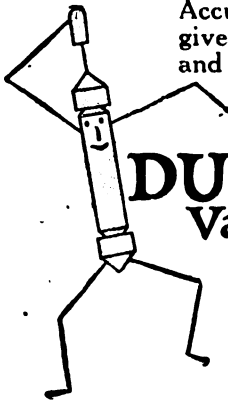
I enclose One Dollar. Please send me—postpaid—the 514-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

Name.....

Address.....



Get full benefit of regeneration



Accurate grid control gives loudest signals and clearest tones

Grid Leaks Guaranteed

DURHAM Variables

For soft tubes:
No. 101-0.1 to 5 megs.
For hard tubes:
No. 201A—2 to 10 megs.

75c each

Durham Base, 30c

How DURHAMS Work

Accurate grid control eases off the point of oscillation—as recommended by the tube makers. There should be no "plop." DURHAMS get you the full benefits of regeneration—by working clear up to the "spilling" point. Try it!

Free folder "C" gives more details. Get yours from dealer or write

Satisfaction Guaranteed

DURHAM & CO., *Inc.*
1930 Market St., Philadelphia

Dealers: Durham leaks will benefit your sales. For they make friends.

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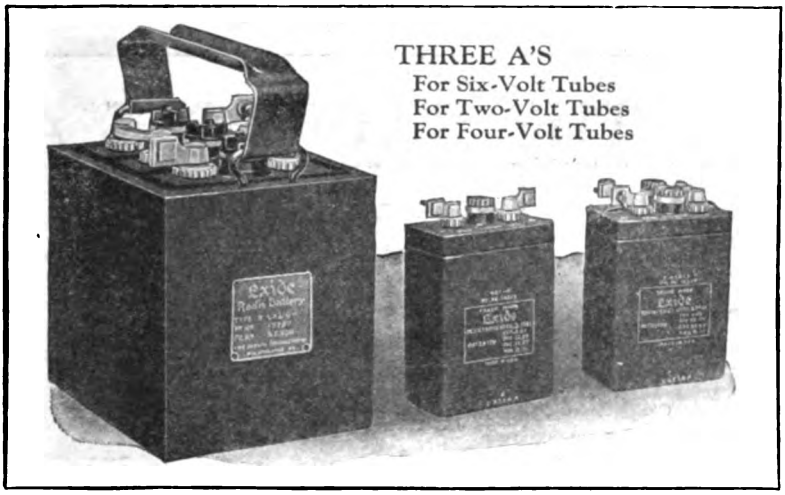

If you take radio seriously

YOU want to tune in distant stations, but there is another thing you want just as keenly—to get what you get *clearly*.

No matter how far or how near the station is, for greatest clearness and for all-round satisfaction, you must use storage batteries. Once you hook up to Exide Radio Batteries you will never be satisfied with anything less. They give uniform current, smoothly, quietly, over a long period of discharge. Like good little boys, they are seen and not heard.

For low-voltage tubes

The two newest members of the Exide family are midgets in size but giants in power. These sturdy little A batteries weigh only five and six pounds each. They furnish in full measure that uniform and unfailing power so essential to clarity and distant reception.

They were specially designed for WD-11 and UV-199 vacuum tubes, but can be used with any low-voltage tube. The two-volt Exide A Battery consists of a single cell. It will heat the filament of a WD-11 or other quarter-ampere tube for approximately 96 hours. The four-volt A battery, having two cells, will light the filament of a UV-199 tube for 200 hours.

For six-volt tubes

Like all Exide Storage Batteries, the Exide A Battery for six-volt tubes is dependable and long-lasting. It is made in four sizes—of 25, 50, 100, and 150 ampere-hour capacities.

On land, at sea and in the air

It is the experience back of Exide Batteries that makes the Exide give such exceptional service in radio. There is an Exide Battery for every purpose. Exides run trucks, start and light automobiles, operate drawbridges, propel under the sea a majority of the world's submarines, send your voice over the wire every time you use the telephone.

Exide B Battery

A majority of all government and commercial radio plants both on land and at sea are equipped with Exide Batteries. The Leviathan is Exide-equipped. The giant dirigible "Shenandoah" carries Exide Batteries for ignition, lights and radio.

It does not pay to get any but a known-to-be-reliable storage battery for radio. Exide Radio Batteries are sold by radio dealers and Exide Service Stations everywhere. Ask your dealer for booklets describing in detail the Exide Radio Batteries, or write us direct.

Exide
RADIO BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

Manufactured in Canada by Exide Batteries of Canada, Limited, 133-157 Dufferin Street, Toronto

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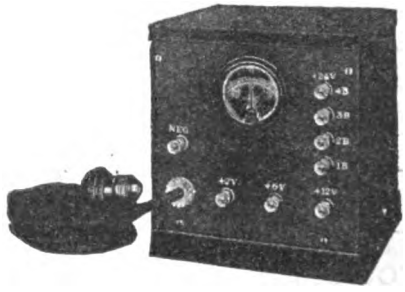
KEEPS THE RADIO SET ALIVE

HANDY CHARGER

A Battery Charger that gives a quick charge economically. No Sticking Contacts. No bulbs nor Liquids. Fully enclosed — beautiful.

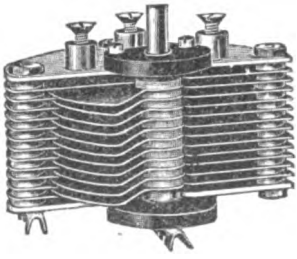
SIMPLEX MODEL—For 6 volt Batteries only. The Most Practical, Most Complete Battery Charger, for only **$16.00**



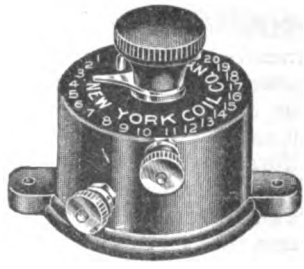
ULTRA MODEL—Charges Them All. Charges 2 volt, 4 volt, 6 volt, 8 volt, 10 volt, 12 volt and 1 to 4 "B" Storage Batteries, with WESTON AMMETER, **$18.00**

INTERSTATE ELECTRIC COMPANY *of St. Louis, Mo.* 4015 Laclede Avenue

INSIST ON NEW YORK COIL COMPANY'S PROVEN RADIO PRODUCTS



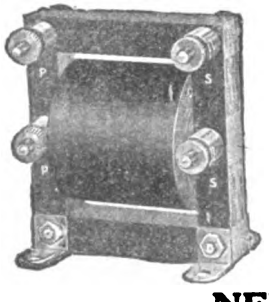
11 Plate... **$1.50**
23 Plate... **2.00**
43 Plate... **3.00**
3 Plate... **1.25**



The New York Variable Grid Leak

Easily tops the field in precision, permanency and efficiency.

Price $1.50



Amplifying Distortionless Transformers

Correct for any tubes.

Price $4.00

Mica Fixed Condensers

Of tested and permanent capacity, ranging from .0001 to .006, 35 cents to 75 cents, of **superior** quality.

.00025 with Leak Mountings, 45c

NEW YORK COIL COMPANY

338 Pearl Street **New York City, New York**

Pacific Coast—MARSHANK SALES CO., 1240 S. Main St., Los Angeles, Calif.

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N & K

NEW MODEL D, N & K Head Set, 4000 ohms. 2¼ in. diaphragm. Heavily nickeled brass casing. Sanitary *leather covered* head bands. 6 ft. cord, durable contact tips. Retail $8.50.

The Phones That the Fans Are All Talking About

YOU have been hearing radio enthusiasts talk about "That imported head set that gives such wonderful tone"; "The head set that is so comfortable to put on"; "The head set with the big phones." It's the N & K 4000 ohm Head Set that they are all talking about.

In less than a year, with practically no advertising, thousands and thousands of these phones have been put into use by radio set owners. So enthusiastic have these owners become, that in homes where several different kinds of head sets are in use, there is always a "scrap" as to who shall use the N & K.

The N & K was designed by one of the world's leading makers, famous over a quarter century for scientific and telephone apparatus. It has *extra large phones*, 2¼ inch diaphragm, with these four results: broader range—equally good on high and low tones; greater comfort to the wearer; the exclusion of outside sounds; and a wonderful mellow tone. The casing of heavily nickeled brass—instead of flimsy stamped aluminum—provides a perfect sound chamber and a special device insures absolutely uniform distance between diaphragm and poles.

Send today for full information about the N & K.

TH. GOLDSCHMIDT CORPORATION
15 WILLIAM STREET NEW YORK, N. Y.

Dealers:

N & K Head Sets mean easy sales, excellent profit. Use them to demonstrate your radio sets, especially the small ones, and you'll sell the set every time. There are no come-backs on N & K Head Sets. As one dealer says after handling them for a year: "I have yet to see one pair come back for repairs." Fully guaranteed. We are exclusive distributors for U. S. and Canada, and carry a complete stock of spare parts. Write for discounts.

——MORE INFORMATION——

Dept. P-2, Th. Goldschmidt Corp.
15 William Street, New York, N. Y.

Please send me folder describing your new N & K Head Set in detail.

Name.....

Street.....

City..... **State**.....

I usually buy radio supplies of.....

.....
(name of store)

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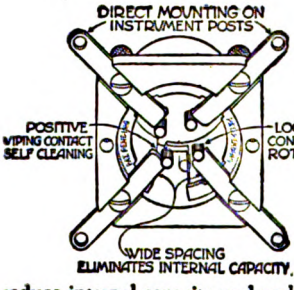
Genuine—

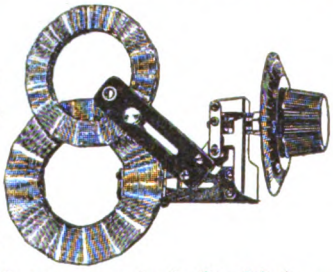
E. J. Flewelling PARTS


DIRECT MOUNTING ON INSTRUMENT POSTS
POSITIVE WIPING CONTACT SELF CLEANING
LOCKED IN CONTACT BY ROTATION
WIDE SPACING ELIMINATES INTERNAL CAPACITY.

Sockets $1.00

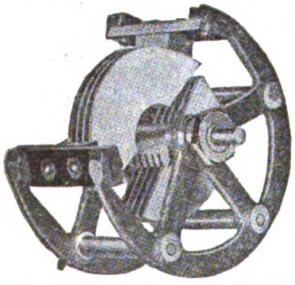
Flewelling Sockets are acknowledged the best socket on the market. They eliminate socket noises, reduce internal capacity and make your set more efficient.

Tuner $8.00



Flewelling Tuners are the utmost in neatness and efficiency. No solid dielectrics in coil field; no loss producing taps or leads. Simplified tuning, produces large volume and is rigidly built.

Condenser $6.00



Flewelling Condensers are made extra rugged, the heavy plates reduce possibility of misalignment. It is as near electrical and mechanical perfection as human ingenuity can produce it. (At your dealer or direct.)

BUELL MANUFACTURING COMPANY
2977 Cottage Grove Avenue
CHICAGO

DIAMOND DIAMOND

"I don't need to look at the 'B' Battery

It's a—

DIAMOND

RADIO PLATE 'B' Battery—"

B batteries are off your mind if they're **Diamond Radio Plates.** More material and more skill goes into them. **You** get MORE out of them. When other batteries would begin to weaken and create noises in your tubes—**Diamond Radio Plates** are still delivering the same uniform, dependable service. Look for the Diamond Trade Mark at your dealer's. Also sent direct C. O. D. Get a **Diamond** NOW.

LIST PRICES

No. B-1, 22½ volts $3.00, 5 binding posts in steps of 1½ volts.
No. B-2, 45 volts $5.50, 5 positive taps.
No. B-16, 45 volts $4.50, 5 taps from 16½ to 22½ volts.
No. B-4, 22½ volts $1.75, for portable sets. 5 taps.
No. 3, Type C, 4½ volts, 3 taps 70c.

DIAMOND ELECTRIC SPECIALTIES CORP.
102 SO. ORANGE AVE., NEWARK, N. J.
Dealers—Jobbers, Write for Proposition

DIAMOND DIAMOND

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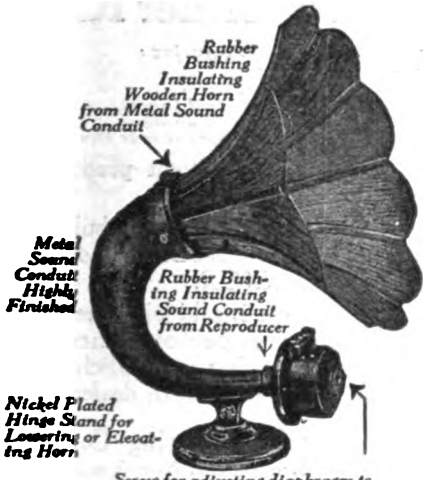
AMPLION


Rubber Bushing Insulating Wooden Horn from Metal Sound Conduit
Metal Sound Conduit Highly Finished
Rubber Bushing Insulating Sound Conduit from Reproducer
Nickel Plated Hinge Stand for Lowering or Elevating Horn
Screw for adjusting diaphragm to meet all conditions of Rec. Sets

Amplion Deagen AR-19
$40.00

Points of Amplion Supremacy

1. The "Amplion" requires no power amplifier. No battery necessary.
2. Connects up to regular head phone binding posts.
3. The diaphragm is made of a special alloy found to have no equal after years of experiment with all other materials.
4. The electro-acoustical device is insulated entirely from the Horn, eliminating distortion, ring or resonance.
5. Non-vibrating wooden horn surpasses all other materials.
6. Adjustable feature makes the "AMPLION" sound true with any make of receiving set, and ensures faithful reproduction.
7. The mechanism has not been hurriedly devised to meet the radio boom; it is not new; it is a development for radio purposes of a loud speaking device that has been used by leading navies of the world for years.
8. The finish and workmanship are supreme.

"That's the clearest reproduction I have ever heard"

This is what one of America's leading radio engineers said when he heard the Amplion at the New York Radio Show in October.

And added to this wonderful clearness is volume and tone quality as yet unequalled.

Simple to connect, no extra battery needed. Insist on an Amplion demonstration before you purchase a loud speaker.

Patentees: ALFRED GRAHAM & CO.

SIGNAL ELECTRIC MFG. CO.
Sole United States Distributors
Menominee, Michigan

BURNDEPT OF CANADA, LTD.
Canadian Distributors – 172 King St. W., Toronto

AMPLION

The World's Standard Loud Speaker

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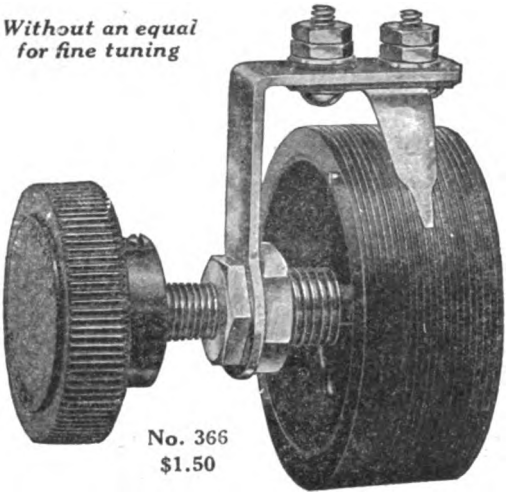
New 1924 Model

Precise Vernier Rheostat

Without an equal for fine tuning



No. 366
$1.50

Featuring :

Single hole mounting.
Single knob control.
Universal for all standard tubes.
Resistance range 0 to 30 ohms.
Critical Vernier adjustment over the entire range.

The use of this instrument produces amazing results—be convinced.

Write today for our illustrated bulletin and test chart describing our *AUDIO TRANSFORMER* and *SWITCH LEVER.*

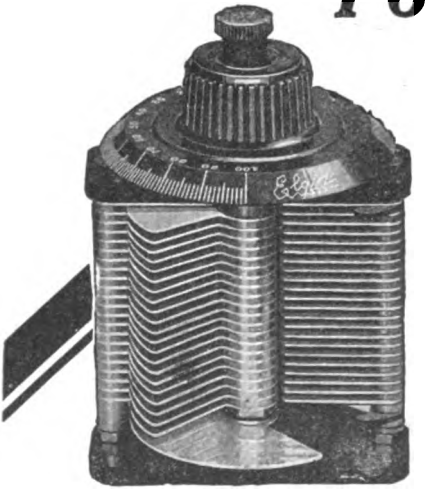
Every instrument is sold with the **guarantee of satisfactory performance.** If your dealer cannot supply you, send check or money order direct to factory with dealer's name.

Dealers and jobbers write for our attractive sales proposition

Precise Manufacturing Corporation
Rochester, New York

Branches
53 W. Jackson Blvd. Chicago, Ill. — **821 Market St. San Francisco, Cal.**
Distributed in Canada by Perkins Electric, Ltd.
Toronto Montreal Winnipeg

For Better Receiving



Pick up those distant stations louder and clearer. Eliminate noise and interference. You can do this when you use

Elgin
PRECISION CONDENSERS

Permanent accuracy and rigidity are built into Elgin Precision Condensers. Plates are made of specially hard rolled aluminum and are of uniform thickness throughout. Special process spacers assure uniform spacing of plates. Adjustable vernier shaft makes it possible to use the Elgin Vernier Type Condenser on any thickness of panel and with dials of different thicknesses.

Size	Capacity	Plain	Vernier
3 Plate	.000063 M. F.	$1.75	$——
11 Plate	.00025 M. F.	2.40	4.00
17 Plate	.00035 M. F.	2.75	——
23 Plate	.0005 M. F.	3.00	4.50
43 Plate	.001 M. F.	4.00	5.50

3" diameter composition dials, 50c extra

FULLY GUARANTEED

See your local dealer. If he cannot supply you send his name with your order to

The Elgin Tool Works
Incorporated
69 N. State St.
ELGIN, ILL.

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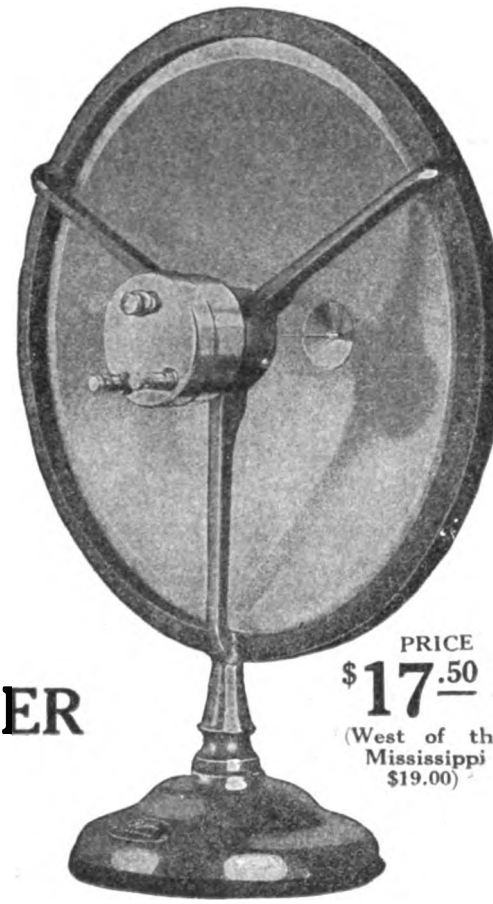
Special Notice

The *New* 1924

Pathé



LOUD SPEAKER

PRICE
$17.50
(West of the Mississippi $19.00)

IS NOW ON SALE

The new 1924 Pathe Loud Speaker is radically different in theory and construction design from any other loud speaker. It is scientifically perfect—the throaty voices of the horn have been finally done away with. The Pathe Loud Speaker actually *reproduces* distance signals clearly and without distortion.
It will add to your radio pleasure to find out the details of the new Pathe Loud Speaker. Step into your dealer's and see it or write us today for free pamphlets and full particulars.

PATHÉ PHONOGRAPH & RADIO CORPORATION
20 GRAND AVE., BROOKLYN, N. Y.
Western Sales Office, 533 Wabash Ave., Chicago, Ill.

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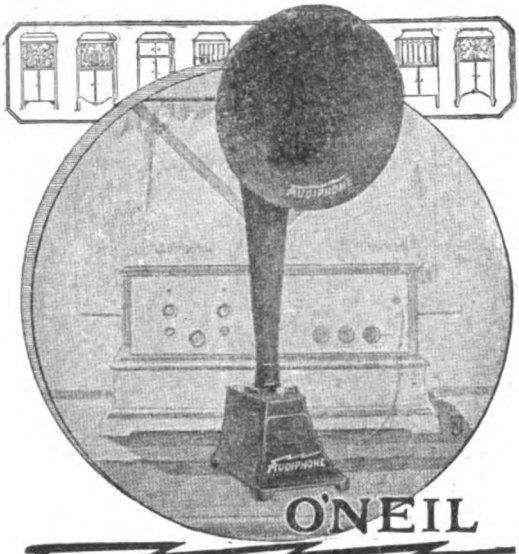


O'NEIL AUDIPHONE

THE highest standard of music reproduction, the phonograph, now equalled by the O'NEIL AUDIPHONE. Designed and built on phonograph principles by phonograph craftsmen and radio-acoustic engineers. A radical improvement over the old earphone type of loud-speaker. The entire voice or instrument is transmitted through the "laminated voice core." Diaphragm adjusted by exterior thumb screw.

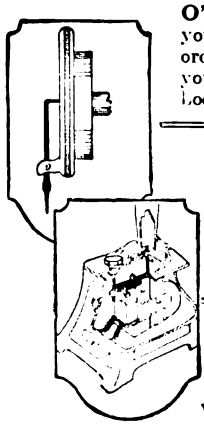
No extra batteries needed. Complete, with connecting cord.

$25

Model in antique bronze

$30

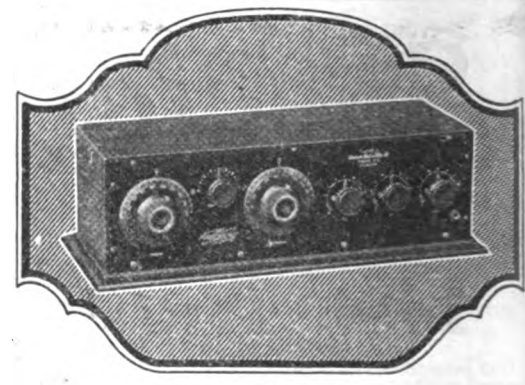
Absolute "money-back-if-not-satisfied" guarantee on every O'NEIL AUDIPHONE. Should your dealer have none on hand, order direct, C. O. D., mentioning your dealer's name. Write for booklet.



Note the similarity of construction between the phonograph reproducer (illustrated in the upper panel) and the reproducer of the O'Neil *AUDIPHONE*: both have a mica diaphragm set in a sound-box chamber actuated by an elbow stylus bar.

O'Neil Mfg. Co.

714 Palisade Avenue
West New York, New Jersey



RADIODYNE

"The Voice of the Nation"

NO LOOPS - - - NO ANTENNA

The RADIODYNE is operated by simply grounding to a water pipe or radiator, and throwing a few feet of wire on the floor. Uses any standard tubes—dry cell or storage battery. Extremely selective. Simple to operate—only two controls.

Stations within a radius of 2,000 miles can be picked up on the loud speaker; any wavelength from 200 to 700 meters.

PRICE $150.00

For use in apartments, boats, automobiles, railroad trains, etc., the RADIODYNE is enjoyable where other receiving sets would not be practical.

When interference, strays, static, etc., make other types of reception utterly useless the RADIODYNE picks up broadcast programs clear and distinct.

Write for illustrated folder which describes the RADIODYNE in detail. Every radio fan will be interested in this new type (antennaless) receiving set.

WESTERN COIL & ELECTRICAL CO.
308 5th St. :: Racine, Wisconsin

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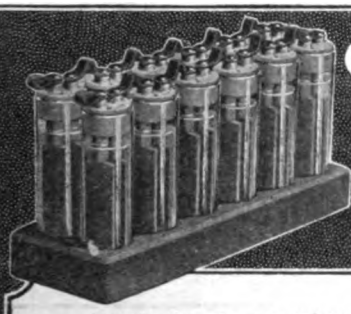


The RāBAT
a Rechargeable Wet 'B' Battery at Only $3.96

A rechargeable wet "B" Radio battery built strictly on storage battery principles. Yet it costs only a trifle more than an ordinary dry cell battery.

The Rabat at the low price of $3.96 has 12 cells with a total of 24 volts and ample capacity. It is noiseless, fool-proof, and compactly constructed. Built on a solid rubber base. Small, but neat and efficient. All elements visible. No internal discharge. More economical. Longer life. Higher and more continuous voltage. Easily recharged at home with aid of inexpensive Rabat Rectifier. If your dealer cannot supply you send direct.

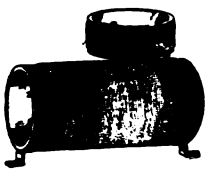
South of Tennessee and West of the Mississippi, East of Rockies—$4.25
West of Rockies—$4.40
Rabat Rectifier for Recharging $ .75

THE RADIO RABAT COMPANY
301 RUSSELL BUILDING Playhouse Square CLEVELAND, O.

12 CELLS The RāBAT 24 VOLTS

SAVE MONEY!

An Amplex Kit costs you 20% to 30% less than the price of all the parts bought separately. Each Kit is complete. No extra parts to buy.



4 CIRCUIT COIL

Built strictly according to Cockaday's specifications. Radion or Bakelite tubing, No. 18 DSC wire. Furnished in Kit, or separate, $5.00.

IMPORTANT

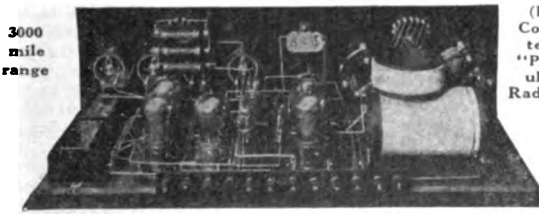
Every part in every Kit is tested, guaranteed, and selected as the most efficient part for that Kit's circuit. Individual parts may be purchased separately at list price.

BUILD YOUR SET

The AMPLEX KIT WAY

The Safe, Simple, Money Saving Way
There is an Amplex Kit for Every Popular Circuit

3000 mile range



(By Courtesy "Popular Radio")

COCKADAY IMPROVED 4-CIRCUIT KIT

Parts	List Price Each
1—Panel 7" x 24" Drilled	$6.00
1—4 Circuit Coil	5.00
2—Amplex 24 Pl. Vari. Cond.	5.00
5—Bakelite Sockets	.75
1—6 Ohm Rheostat	.75
3—20 Ohm Rheostat	1.00
2—Grid-Densers	1.25
2—Grid Leaks, Var.	.75
1—Jacks, single	.65
2—Jacks, double	1.00
2—Amplex Transformers	5.00
2—Switch Levers, etc	.50

Parts	List Price Each
3—48000 Ohm Res.	$1.25
1—Res. Mounting	1.25
1—.0005 Cond.	.45
1—.00025 Cond.	.45
2—P. P. Transformers, pr.	12.50
1—Potentiometer	1.00
1—Baseboard	1.50
1—Set of plans, etc.	1.50
12—Binding Posts	.10
Bus bar, etc.	.50

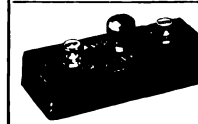
	List Price	Kit Price
1 Tube Cockaday Kit	$26.60	$19.75
3 Tube Cockaday Kit	53.80	42.50
5 Tube Cockaday Kit (Push Pull)	71.25	56.50

AMPLEX INSTRUMENT LABORATORIES
Dept. P :: 57 Dey Street, New York, N. Y.

SAFE AND SIMPLE!

The Amplex Kit takes the "guess" out of Radio.

DRILLED PANEL. COMPLETE INSTRUCTIONS and blue print for wiring and assembling with each Kit. No special skill or technical knowledge required. Safe and simple to build your set the Amplex Kit-Way.



"GRID-DENSER"
(Variable condenser, 0 to .0006 mfd.)

Specified by Cockaday Absolutely essential to control oscillations. Will improve any circuit. With Kit, or separately, $1.25.

48,000 Ohm "Lavatite" Resistances, each, $1.25

FREE

Our engineers will answer any Radio questions, or help you with any wiring or assembling problems. This service is absolutely FREE. Just write to Service Dept.

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POPULAR RADIO with Your Other Favorites—at Special Club Prices!

Save money on these magazine bargains They are figured at rock bottom prices

GLANCE over this big list of magazine bargains that have been arranged for your benefit. Here is your chance to get almost any magazine you want—and by ordering *now* with a year's subscription to POPULAR RADIO you get *both* magazines at special low prices.

If you are already a subscriber to POPULAR RADIO or to any of these other magazines, these special club offers allow you the privilege of renewing or extending your present subscription for an additional year *at a considerable saving of money.*

Fill your magazine requirements *now* for the coming year and save money. Simply check the offer you want and mail the coupon below, with your remittance, without delay.

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McCall's	$3.25 less $2.50=	$0.75
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Natural Re-PRODUCTION

Atlas

LOUD SPEAKER

$25

TRADE MARK

SCORES of letters, sent us by enthusiastic owners of Atlas Loud Speakers, reveal how great is the difference between ordinary loud speakers and this real radio reproducer. It is the difference between real and artificial revival of the music broadcasted. The exclusive "double diaphragm" feature responds equally true over the entire range of musical cycles. There are no distortion points. This device is adjustable to your set and particular receiving conditions. ***Write for Illustrated Booklet "B."***

Hear the Atlas Loud Speaker

Ask your dealer for a demonstration. Submit it to any reasonable test. Get the proof NOW.

Letters from Users Requested

Make Your Own Loud Speaker with THE ATLAS UNIT, with phonograph attachment $13.50

(***Unit without Attachment $12.50***)

Sole Canadian Distributors: The Marconi Wireless Telegraph Company of Canada, Limited, Montreal, Canada.

Multiple Electric Products Co. Inc.

Makers of Multiple TIME-LAG Mono FUSES

7 Orange Street, Newark, New Jersey

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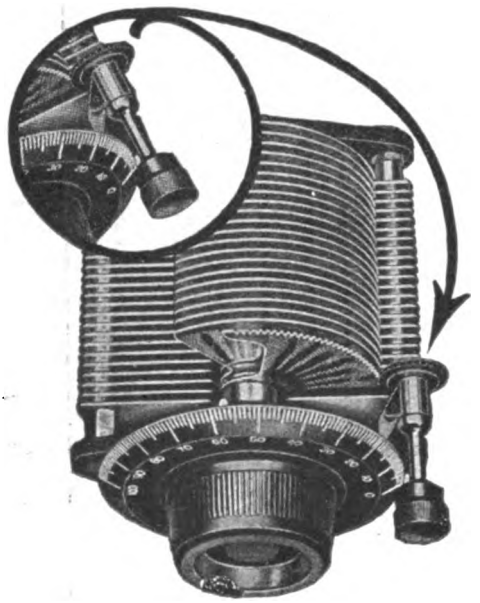

HEATH'S

Radiant Condensers

When you put **Heath Radiant Condensers** behind a panel, you can forget about them. They will **always** tune as perfectly as the day you mounted them. Absolute alignment is permanent, because the plates are protected against warping and buckling by the **Heath** process of stamping and tempering. Each plate is PERMANENTLY FLAT.

Vernier With a Hairline Adjustment

Separate vernier adjustment—reducing gear meshed into teeth cut in rim of vernier plate. Ordinary adjustment reduced to infinite fineness. Absolutely positive adjustment—without bucklash.

Write for illustrated booklet and name of the nearest Radiant Dealer.

Prices Vernier Type

13 Plate including 2¼" dial and knob..... **$5.00**
25 Plate including 2⅞" dial and knob..... **5.50**
45 Plate including 2⅞" dial and knob..... **6.50**

Jobbers and Dealers Write Immediately for proposition

HEATH RADIO & ELEC. MFG. CO.
204 First Street Newark, N. J.

Lowest Battery Costs

Rosendal "B" Batteries come from our own factories direct to you. They're fresh-tested — and are sent all charges prepaid.

A Rosendal battery is built right; of raw materials that have been carefully analysed and are known to be the best that can be had—and then compounded under Rosendal Formulas which are recognised and used by representative Battery Manufacturers throughout the country. That is why Rosendal can guarantee the battery you get.

Money back if not satisfied

	Large	Medium	Small
22½ Volt plain.....	$1.66	$1.33	$0.93
22½ Volt variable.....	1.84	1.50	1.00
45 Volt plain.....	3.33	2.33	——
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Send money order or order for C. O. D.

ROSENDAL & Co

Chemical and Radio Engineers
2 and 4 Stone Street New York

Send for descriptive circulars on other radio items

The Tube's the Thing!

Get Radio Reception Without Noise

(½ size)

$5 Each

MYERS TUBES

Guarantee Perfect Clarity

Hear without noise or tube hiss with Myers Tubes. They give much greater amplification, are perfect Detectors and Oscillators. They add 50% to the efficiency of your set because they reduce interference.

TWO TYPES: Myers Dry Battery Tube 2½ Volts—¼ Ampere. Myers Universal operates on either 3 Dry Cells or storage batteries. $5.00 each. Ready for mounting. No sockets or extra equipment needed.

See that you get the New Improved Myers Tubes with the Coating. Others are not guaranteed.

At your Dealer, otherwise send purchase price and you will be supplied Postpaid.

SOLE MANUFACTURERS

E. B. Myers Co. Ltd.
Radio Vacuum Tubes

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Music at its Best!

Full, clear, rich, beautiful—MUSIC MASTER brings into your home the majestic tones of the pipe organ, the incomparable master instrument of the musical world.

MUSIC MASTER gives you the *truth* of each soft strain, every arpeggio, the inspiring, kingly chords and the rich, rolling bass tones.

Why not let *everyone* hear the organ? Flood the whole room with its majestic music—simply by connecting MUSIC MASTER to your radio set.

MUSIC MASTER is equipped with a wood amplifying bell; and wood, properly shaped as a horn—furnished only with MUSIC MASTER—is the one material that makes possible the perfect reproduction of the actual, living tones themselves.

Dealers Everywhere

14-inch horn (mahogany or spruce) for the home $30

21-inch horn (mahogany only) for concerts $35

Comes complete, ready to attach in place of headphones. No batteries required for its operation.

MUSIC MASTER CORPORATION
Formerly General Radio Corporation
Makers and Distributors of High Grade Radio Apparatus
S. W. Corner 10th and Cherry Streets, Philadelphia
CHICAGO *PITTSBURGH*

Music Master
RADIO REPRODUCER

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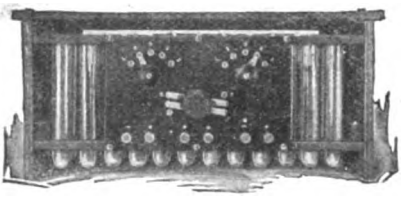

100 Volt Panel type

"The most popular in this vicinity—"

"We wish to commend your storage "B" battery," says the Southern Radio Sales Co., Newport News, Va. Such endorsements come to us unsolicited. KIC-O Batteries always make good. Alkaline type, won't sulphate or buckle. Life unlimited. Not harmed by short-circuiting, overcharging, idleness. Panel switches give single cell variations. Recharge from any 110-volt A. C. line with small home rectifier. Charge lasts 3 to 6 months in detector plate circuit.

GUARANTEE

Your money back on any KIC-O Battery if not satisfied within 30 days. Write for full information on "A" and "B" Batteries.

Unmounted Rectifier.....**$1.00**
Mounted Rectifier.....**$2.50**

Cells	Volts	Price, Plain	With Panels
16	22	$5.50	
24	32	7.25	$11.75
36	48	9.50	14.00
50	68	12.50	17.00
78	100	17.50	22.50
108	145	23.50	28.50

KIMLEY ELECTRIC COMPANY, Inc.
2667 Main Street **Buffalo, N. Y.**

KIC-O **Storage "B" Batteries—long service, low cost**

Bakelite Jack

CICO

2-Way Plug

Price 60c

The CICO Bakelite Jack is the finest article of its kind ever produced and the last word in scientific radio construction. Moulded completely from Bakelite. No metal in frame construction. Wires connected to Nickle-Plated Brass Binding Posts. No soldering necessary. Special whitened phosphor Bronze Springs used throughout. Contact points of Sterling Silver.

A Radio Plug that embodies the most advanced engineering principles. A recognized leader for 2 years Loud speaker and headphones or 2 sets of headphones can be connected simultaneously to the same plug by inserting 2 cord tips instead of one in each slot. Fits all standard jacks. Takes all types of tips.

No. 30-Single circuit open	$.80
No. 31-Single circuit closed	.85
No. 32-Double Circuit....	.90
No. 33-"A" Battery Switch	.90

Consolidated Instrument Company of America, Inc.
41 East 42nd Street
New York

Every CICO PRODUCT is packed in a distinctive GREEN BOX and unqualifiedly guaranteed against all defects.

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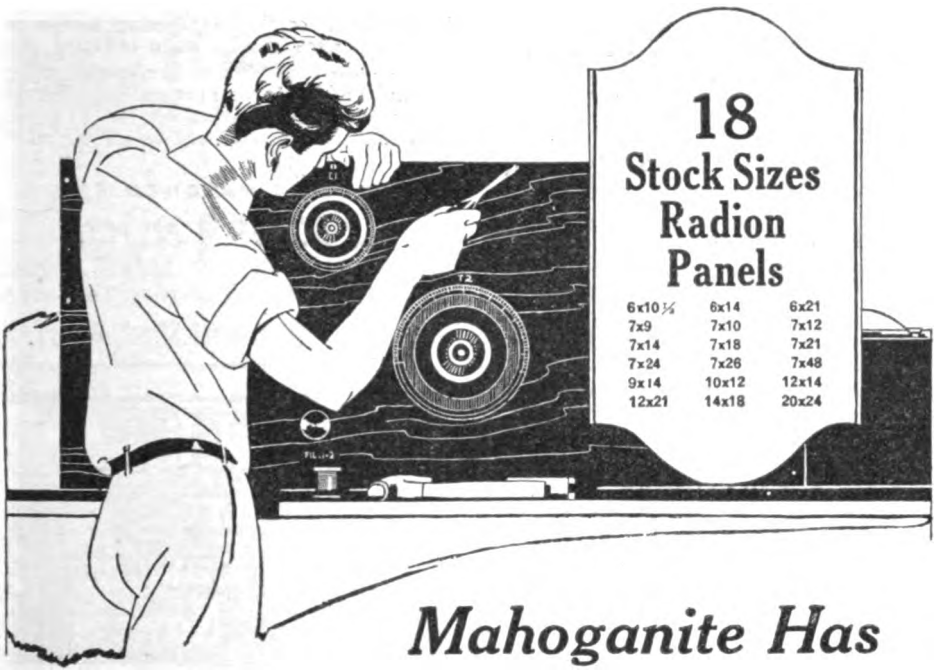
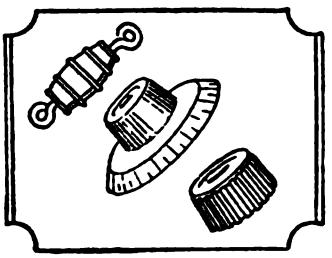


Mahoganite Has the Beauty of Polished Mahogany



Mahoganite Radion Panels have a satin-like finish comparable to that which age and a skilled cabinet maker give to mahogany. Radion Dials and Knobs are also made in Mahoganite, to match. Sold at all good radio stores or write to us for catalog.

Look for this stamp on every genuine RADION Panel. Beware of substitutes and imitations.

RADION

The Supreme Insulation

PANELS

AMERICAN HARD RUBBER CO., 11 Mercer St., N. Y.

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Como Duplex Transformers

(PUSH-PULL)

The COMO DUPLEX SYSTEM of audio-frequency amplification gives the maximum volume without distortion and tube noise.

There is a combined filtering action which assures perfect results when ordinary amplification fails.

It can be added to your present amplifier, giving you power amplification on the weak signals that more of the ordinary amplification would kill.

SOLD IN MATCHED PAIRS

$12.50 per pair

A copy of "HOW TO MAKE A POWER AMPLIFIER" is yours for the asking.

COMO APPARATUS COMPANY, 446 Tremont Street, Boston, Mass.

DID YOU GET LONDON?

AT this writing, two of the three Philadelphia stations submitting authentic records of having tuned in London were equipped with the

TURN-IT
adjustable GRID-LEAK

THESE leaks fit all standard mounts, give exact values for the tubes, circuit and signals, and are so simple in operation that anyone can instantly understand and appreciate all the desirable features of this unique and practical radio mechanism. Sold either by your dealer or by

CHARLES E. BONINE
20 So. 15th Street
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75c.

If ordered C.O.D. add 10c

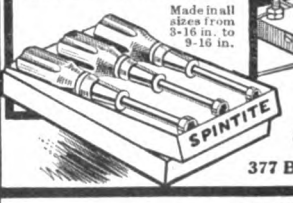
New Hook-Ups Are Easy Now

You'll save hours of labor and make connections as solid as soldering with

Stevens Spintite Wrenches

Hollow stem goes down over projecting screws—hex socket gets firm grip—ebonized handle for comfortable leverage—very easy to reach difficult places. Used by radio manufacturers.

Made in all sizes from 3-16 in. to 9-16 in.



Send $1.00 for set of 3 popular radio sizes

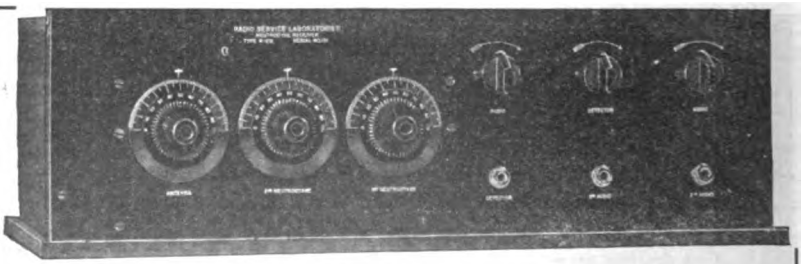
STEVENS & COMPANY
Toolsmiths since 1899
377 Broadway, New York

Stevens SPEED UP *Tools*

"The Best Built Set in America"
R-212

RADIO SERVICE LABORATORIES

Licensed by I. R. M., Inc., under Hazeltine Patents



Embodying the Hazeltine Neutrodyne circuit in an improved form as to neutralization, workmanship, quality, appearance and efficiency of operation.

Radio Service Laboratories, 1000 11th Ave. Asbury Park, N. J.

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Radio Fans

Here Is a Winner Armstrong Regenerative Set Receiving Radius 600 Miles

$23.25

Order Direct From This Advertisement.

FREE Radio Catalog!

HERE is a money saving Radio Outfit that will bring the news of the world—concerts, lectures and stock reports—into your home. Sold complete with head set, tube, batteries, aerial and ground wires, for **only $23.25!** Connections simple and plainly marked. Easy to tune. Order NOW! Shipping weight, 12 pounds. Shipped from CHICAGO or PHILADELPHIA store.

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Save money on your radio supplies, and get **guaranteed quality!** Our big **FREE Book** shows hundreds of bargains in complete sets and parts. Many new hookups, complete list of broadcasting stations. Contains "How to Build an Aerial." Mail coupon!

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Mail coupon today to store nearest you for Free Radio Catalog.

Send me FREE Radio Catalog No. 89P71.....

Name.....

P. O.....State.....

Rural Route.....Box No.....

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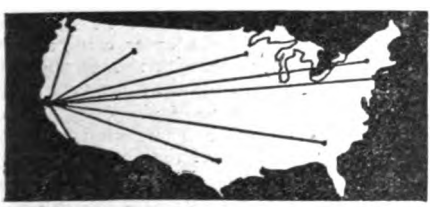
Licensed under the Armstrong Patent No. 1113149 for amateur experimental and scientific uses only.

Sears, Roebuck and Co.

The World's Biggest Mail Order House



ON ONE TUBE

Broadcasting from Atlantic Coast, Canada, Mexico, Cuba & Hawaii heard in Calif. by users of the CROSS COUNTRY CIRCUIT. Range due to simplicity. One tuning control. ANY NOVICE can build easily and cheaply. Dry cell tubes used. No soldering. Complete instructions. Blue print panel layout. Assembly Photo, etc., postpaid 25 cents. Stamps accepted.

VESCO RADIO SHOP, Box PR-117, OAKLAND, CALIF

RADIO "B" BATTERIES

AT FACTORY PRICES

Greatest radio "B" battery on market. Full number voltage taps; QUALITY GUARANTEED; LOWEST PRICES; brings in concerts LOUDER AND STRONGER; **will work on any tube or loud speaker.** Order by number TODAY with check, money order or pay postman C. O. D.

No. 122B 22½ volt variable, regularly $2.25... **$1.52**
No. 122A 22½ volt variable, regularly 3.00... **1.85**
No. 145A 45 volt, 8 taps, regularly 5.50... **3.25**

AYRES BATTERY CORPORATION, Cincinnati, Ohio

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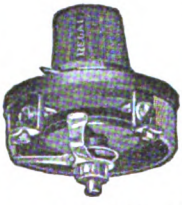
Regal

Radio Apparatus
That Lives Up to Its Name

New "Regal" No. 162 Double Arm Inductance Switch

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of holes. No more chipped panels. Complete with hard rubber Knob and Dial

$1.50



New "Regal" No. 120 Vernier Rheostat

For fine filament control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market. Complete with Knob

6-Ohms.....**$1.25**
30-Ohms.....**1.25**

New "Regal" No. 200 Audio Frequency Amplifying Transformer

For clearness of tone, amplification of voice and music from nearby and distant broadcasting stations, is unequaled by any Transformer on the market

3½ to 1 Ratio...**$4.25**
5 to 1 Ratio... **4.50**

At all good dealers—otherwise write direct for complete descriptive folder No. 24, sending dealer's name.

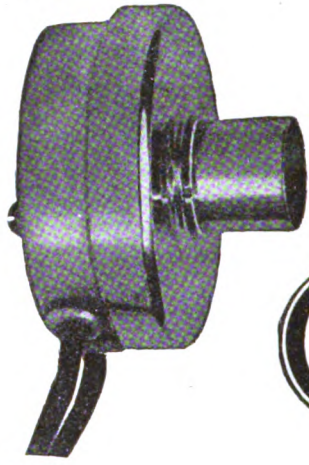
AMERICAN SPECIALTY CO.
Bridgeport, Conn.

The Hines Radio Desk

Has a large compartment for batteries that is very accessible. Two good size drawers for wire, tools, parts, etc. Designed by a man of long experience in the Radio field. Constructed from selected materials and built in a modern factory by skilled workmen. Finished in Oak, Mahogany or Walnut. Complete details and exact specifications sent upon request.

HINES RADIO DESK COMPANY
Owensboro, Kentucky

Listen to the Difference!



CIC

Phonograph Attachment $6.50 with 6 feet of cord

You never heard of a high quality phonograph attachment at this price, and you never heard a tone equal to the C. I. C. Unit at any price. Long years of experience with loud speakers and head phones only have made the above price and the quality possible.

Mica diaphragm mounted between resilient cushions, an adjustable air gap, and extreme accuracy of manufacture give exceptional volume and quality of reproduction.

The unit is equipped with an adapter to fit both the Victor and Columbia phonograph, or for one dollar extra adapters will be furnished to fit Brunswick or Edison phonographs. The adapter can be removed, making it suitable for use with any of the types of horns which are designed to take a head set receiver.

You are wise in utilizing your phonograph as a loud speaker. Be equally wise in transmitting the true beauty of sound by means of the C. I. C. Phonograph Attachment.

Send for booklet "Loud Speaker Facts" which gives full information regarding the C. I. C. Loud Speaker and Phonograph Attachment

CONNECTICUT INSTRUMENT CO.
STAMFORD, CONN.

Representatives

GLOBE COMMERCIAL CO.
San Francisco, Los Angeles, and Salt Lake City

L. D. READ
919 Lake View Boulevard, Seattle

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better! in any circuit

All moulded base, eliminating the capacity effects of brass shells. Draws ¼ ampere.

DEALERS:—Write at once!

The MAGNATRON DC201A is a more sensitive detector and a more powerful amplifier. It will bring in stations you have never heard before. It will increase the volume from your loud speaker.

Get a Magnatron DC201A from your dealer today and note the difference! Like the Magnatron DC199 and the Melotron DC12A, this tube lists at $6.50. *A special price of $5.50 if your dealer doesn't stock these tubes and you send us his name!*

CONNEWEY ELECTRIC LABORATORIES
309 Fifth Ave. NEW YORK CITY

WEIGHS ONLY 8 OZ

The Scientific

THE PHONE IT TOOK A SOLID YEAR TO DESIGN

A $200,000.00 COMPANY stands squarely back of the guarantee on every *Scientific* headset

SEND NO MONEY!

20,000 TURNS EQUIVALENT TO 3,000 OHMS

Order TODAY by Postcard and Pay Postman on arrival

$2.95 POST-PAID

LOUD SPEAKER UNIT $1.95

We Guarantee The *Scientific* Headset to be the greatest value on the market. Try it for five days. If not satisfactory send it back and your money will be refunded immediately. Circular on request. Dealers wanted.

THE SCIENTIFIC ELECTRIC WORKS
98 Brookline Ave. DEPT. J BOSTON, MASS.

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SUPER-HETERODYNE

"The Rolls-Royce of Reception"

TYPE "S R" Radio Frequency TRANSFORMERS

An instrument especially designed to amplify at a sharp peak of 10,000 meters, and perfected to function at maximum efficiency in the best designed receiving apparatus in the world.

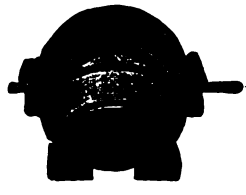
THE RIEGER-BAILEY CO. OF AMERICA

Price $7.00
at best radio dealers or direct from the manufacturer. Give dealer's name if ordered direct.

539 Real Estate Trust Bldg.
Philadelphia, Penna.
Bell Telephone Walnut 7475

DEALERS and JOBBERS
will find this a particularly active and attractive line. Write for details.

BETTER—
and at a Lower Price



A scientifically accurate instrument for long distance tuning. R. P. C. Variometers are molded of Mahoganite Bakelite. Sturdy in design, neat in appearance and easily mounted. Price $5.00

R. P. C. Variable Condensers

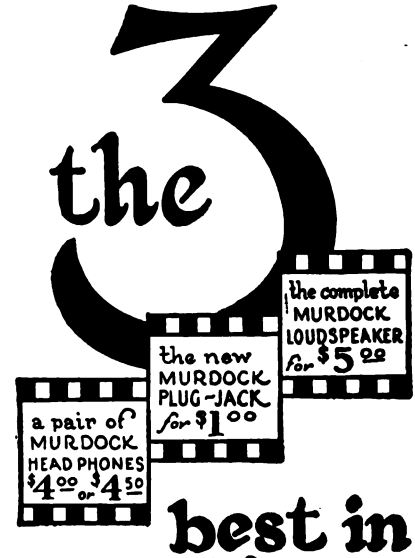
permit you to tune in desired stations without the least bit of interference. The design of these condensers guarantees perfect contact at all times.

Price $1.50

Dealers and Jobbers:
Write for attractive proposition

RADIO PRODUCTS COMPANY
Westport, Conn., U. S. A.

MURDOCK RADIO



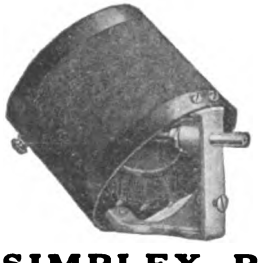
best in radio

AT ALL RADIO DEALERS

If your dealer cannot supply you, send money direct and your order will be promptly filled.

WM. J. MURDOCK COMPANY
354 Washington Ave., Chelsea, Mass.

THE NEW SIMPLEX



180° Vario-Coupler with Special Spider Web Rotor will bring in those distant stations you are trying for. An exceedingly efficient and neat coupling device which will cover all broadcast wave lengths up to 600 meters.

Price - - $3.50

SIMPLEX RADIO CO.

1015 Ridge Ave. Phila., Pa.

WE REPAIR
The Following
RADIO TUBES

WD-11	$3.50	UV-199	$3.50
WD-12	3.50	C-299	3.50
UV-200	2.75	UV-201A	3.50
UV-201	3.00	C-301A	3.50
C-300	2.75	UV-202	4.00
C-301	3.00	C-302	4.00
DV-6	3.00	DV-6A	3.50

Mail orders solicited and promptly attended to.

Dealers and Agents Write for Special Discount.

H. & H. RADIO COMPANY
Clinton Hill Sta. P. O. Box 22-E. Newark, N. J.

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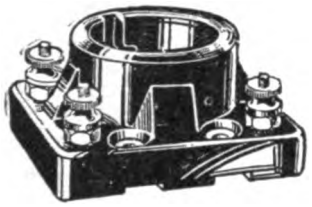
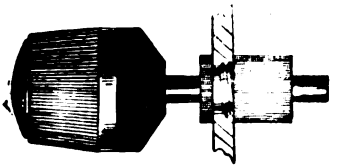
FLERON RADIO SPECIALTIES



The Porcelain Sockets

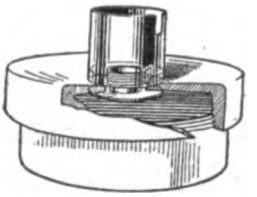
Very carefully made. Brass parts nickeled. Black Glaze. Two sizes. Standard Bulbs and U. V. 199.

Each socket in a carton. 35c. each.



The Vernier Adjuster

The best adjuster on the market. Spring holds head away from dial when not in use. With slight adjustment spring can be made to hold head against dial if desired. Patented. 65c.



The Phono Adapter

Fits through the hole of the receiver cap and then slides on the phonograph tone arm. Fits Victor, Columbia, and others. Works perfectly. Only 35c. ea.

The Porcelain Insulators

Lowest power losses in the antenna. Dielectric absorption reduced to minimum because of very low phase difference of Fleron Porcelain. Very tough body. Solid Black Glaze. Seven sizes, 20c to $1.60. Each insulator in a separate carton.

The Stand-Off Insulator

Fills the much-needed requirement for a good strong looking and practical stand off insulator. Meets every requirement of the Board of Fire Underwriters. $1.25 each.

For Sale by all Good Jobbers and Dealers **M. M. FLERON & SON, Inc., 112 No. Broad St., Trenton, N. J.**

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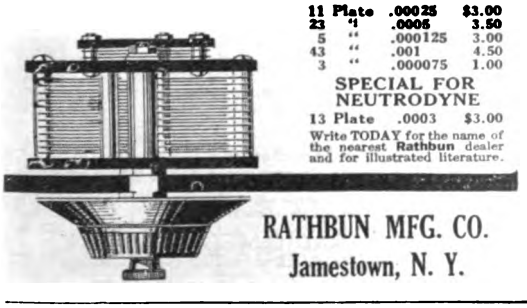
SINGLE-HOLE MOUNTING

SUPERIOR CONDENSERS

COMPLETELY protected mechanically and dielectrically by full circle Bakelite end shields. The entire instrument is more rigid and hence more **accurate.** Just one of the differences between average condensers and RATHBUN. Only one hole needed to mount, better, long brass bearings, stator plates anchored in milled tubes with a variation of **less than two-tenths of one-thousandth of an inch.** Write for literature and name of the nearest **Rathbun** dealer.



LIST PRICES			
11	Plate	.00025	$3.00
23	"	.0005	3.50
5	"	.000125	3.00
43	"	.001	4.50
3	"	.000075	1.00

SPECIAL FOR NEUTRODYNE

13 Plate .0003 $3.00

Write TODAY for the name of the nearest **Rathbun** dealer and for illustrated literature.

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BLUE SEAL

Howard

Radio Co. Inc. GUARANTEED PRODUCTS Chicago, U.S.A.

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No. 1001
6½ Ohm Rheostat..... $1.10
25 Ohm Rheostat..... 1.10
40 Ohm Rheostat..... 1.10
Patd. 870,042

HOWARD

No. 1002
6¾ Ohm Micrometer Rheostat.... $1.50
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Patd. July 10, 1923

HOWARD

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200 Ohm Potentiometer .$1.50
400 Ohm Potentiometer .2.00
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Ask the man behind the counter to show you the **Howard** line of quality Radio Merchandise. Every piece is sold with the **guarantee** of **satisfactory** performance.

Jobbers write for discounts.

Send two cents for folder.

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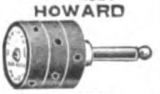

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Multi Terminal Receiver Plug, instantaneous connection for as many as six pairs of standard receiver tips..... $2.00
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HOWARD RADIO CO., Inc.
4248 North Western Ave., Chicago, U. S. A.

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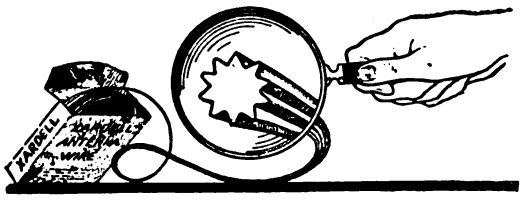

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$2.00

PER HUNDRED FEET

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Use this antenna wire and enjoy the full possibilities of your set.

Sold in coils 100 feet, 200 feet and 500 feet. Order direct or from your nearest dealer.

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UTICA, NEW YORK

THE NEW

METALECTRIC SOLDERING IRON

Operates with the Simplicity—
Ease and Efficiency of a
Pencil on any Electric Current

ACCEPTED
As the Logical Solution
to Radio Soldering
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Ample Heating Capacity
Handle Always Cool

$5.50
"Worth it"

"An All-metal Quality Instrument with a worthwhile Guarantee"

of Your Dealer or Write

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Vernier

The highest type electrical instrument made for controlling resistance.

Recommended by all Scientists familiar with it, where close adjustment is desired.

6 Ohms—Most Tubes
25 Ohms—201-A and 301-A
40 Ohms—199 and 299
$1.75 each—any resistance

"Hear a set that uses one"

Non-Vernier or The Cartridge Rheostat

Interchangeable resistance Cartridges clip in without removing the Bracket from the panel.

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Complete Rheostat $.80
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Potentiometers.. $1.45
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$35.00

Highest quality loud speaker made. CAST ALUMINUM vibrationless horn, extra large and sensitive unit. Adjustment lever tones down local stations and strengthens weak signals from distant stations just like focusing a camera.

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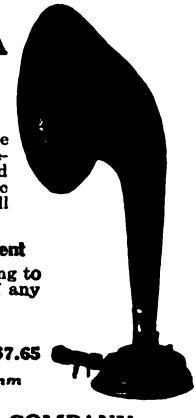

Same wonderful unit, with same lever for instantly increasing or decreasing distance between poles and diaphragm. Fitted with non-metallic horn, 21½ inches high with bell 10 inches wide.

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Same giant size unit with coupling to make a high grade loud speaker of any phonograph. **$10.00**

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gives
REAL LONG DISTANCE
and preserves the natural tone of Broadcasting, both vocal and instrumental, exactly as sent through the Microphone

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Can be used with any amplifying tube on the market with excellent results

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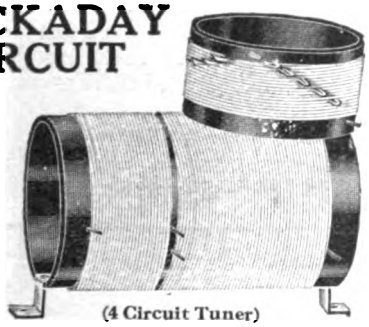
EASTERN COIL SETS

for the **COCKADAY CIRCUIT**

are the standard, and in universal use due to their proved efficiency in this wonder circuit



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Original and new improved hook-ups with material lists FREE with each set of coils.

Either Set may be used for original or new improved hook-up.

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Charges 2-volt peanut tube batteries, 6-volt A Batteries, 6 and 12-volt automobile batteries, and 1 to 4 B batteries. Bakelite panel, glass top. Harmonizes with any receiving set. At good radio shops.

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Complete Plans of

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Each drawing is enclosed in Manila Envelope with **full size blue print** for drilling panel and wiring.

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The only book out that gives you a complete, permanent record of your receptions over a **long period.** Has over 200 ruled logs for entering in ink all the stations received each day with spaces for call letters, distances, remarks, &c.

Also gives Morse Code, latest list of broadcasting stations with new wave lengths, call letters and slogans. Bound in stiff, durable covers.

Send no money with your order. Just pay the postman, on delivery, 50c. plus a few pennies postage.

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The Saturn

"Above the Ordinary" Radio Products

Automatic Plug

Nothing to solder or take apart. Cord terminals inserted, **instantly** gripped, a touch on the lever, **instantly** released. Each Saturn Plug sealed to protect you. Guaranteed.

List Price **$1**

Perfect Jack

Crowfoot offset and solder and flux on blades all ready for soldering. Best materials—Spring German silver blades, rounded corner brackets of nickel-plated brass, and sterling silver contact points. Quality throughout.

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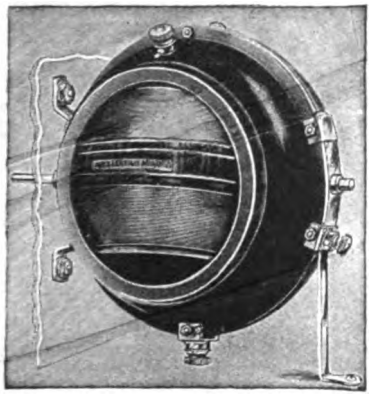

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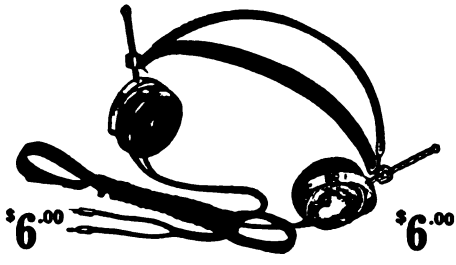

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UNIT FOR
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With Pair of Phones
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A loud speaker on one tube

Tri-Coil
A Radio Frequency Transformer that gives remarkable results in **REFLEX** and **RADIO-FREQUENCY** circuits.

Tri-Coil
Assures very long distance on all wave lengths—and preserves the natural tone of Broadcasting exactly as sent through the microphone.

Price $2 At your dealers—or direct by mail on receipt of price.

FREE illustrated drawing of one tube "Tri-Coil" Reflex Circuit, which will operate loud speaker on request.

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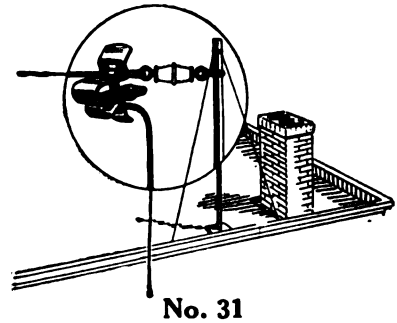

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PRICE 10c

Snap larger connector over Antenna Wire; insert Lead-in Wire into smaller clip and a perfect connection is the result.

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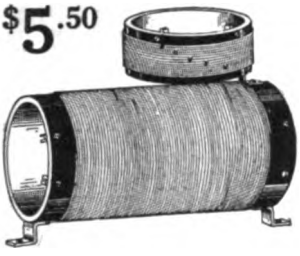

Low Dielectric Losses

Scientifically built of hard rubber wound with silk covered non-shellaced wire. Does not absorb moisture like ordinary coils. Gives low leakage, low distributive capacity, low resistance. Copper terminals—no loose ends, no stray wires. Built in strict accordance with L. M. Cockaday's specifications. Over twice as efficient by actual test, as ordinary coils. Absolutely guaranteed.

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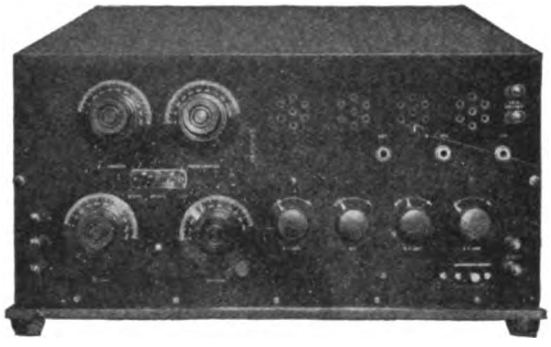

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Having one stage Radio Frequency, Tuned Impedance, Detector and Two Stages of Audio Frequency.

All apparatus mounted on panel 10 inches high, 21 inches long, and set in panel cabinet 10 x 21 x 10 inches deep.

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IMPROVED!
Universal Plug

The Pacent "Forty" already popular as an efficient and low priced plug, has now been greatly improved by a new type of connector, greatly simplifying the method of connection. You need only to insert the cord tips and clamp the shells together to obtain that desired *biting* contact. Connections are stamped to indicate polarity, and all metal parts are satin nickel finished.

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Three stages of Audio Transformers to select from.
2 to 1 and 4 to 1 ratios at.....$4.45
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Radio types from 150 to 750 meter ranges.$2.75
As an added factor of refined radio receiving use Reliable Neutralizing Condensers, only.....75c

The RELIABLE PARTS MFG. CO.
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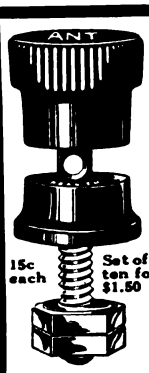

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Simplify the most complicated hook-up

Tell at a glance whether it is Antennæ, Ground, Fones, A or B battery, etc. Name neatly engraved *for keeps* on top of each post. (See illustration.)

Knobs Can't Come Off

The irremovable knobs save time, trouble and petty annoyances. "Read 'ems" add to the appearance of any set. Don't be without them. Price 15c each. Set of ten $1.50. If your dealer can't supply you with "Read 'ems" order direct.

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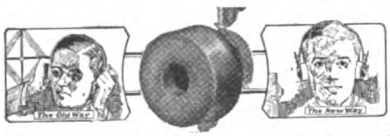

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The BATES Ear Cushion takes the headaches out of headphones. Improve the hearing qualities of **your** set 100 per cent. with

The BATES EAR CUSHION

Slips over any radio phone—instantly and easily. Cushion your ears and hear in comfort. Costs little—worth lots.

Postpaid Anywhere in U. S. for $1.00 per pair.

DEALERS: Write for special discounts.
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Vacuum Tubes
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WD-11, WD-12, UV-201A, UV-199
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Quick service. All tubes repaired by us guaranteed to work as good as new

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Crystals Are the Best Yet! KEEP YOURS

At Los Angeles I receive W J A Z Chicago. W O C Davenport and many other distant stations on mine—you can do the same on yours. Folks come from all over Los Angeles to hear the one I made.

I show you how to make your crystal set into the best receiver you could hope to own. Send $1.00 for detailed instructions and 2-color wiring chart or send stamped envelope for further information.

I have no parts or sets to sell.

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COMPLETE $10.00 Postpaid

Use your headset for 2 purposes. Exceptional combination value. Every pair of phones *tested*. *Guaranteed* to give results. Ideal home loud speaker.

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Use
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A complete set at a special price.

And they're EBY pos'ts, so the tops don't come off.

Your dealer will have them and will show you other popular markings.

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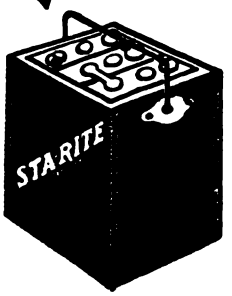
And Guarantee You in Writing 2 Years of Better Battery Performance

STA-RITE RADIO BATTERIES are made especially for Radio and the big saving is made possible by coming direct to you instead of thru distributors, dealers, etc. Boxes are made of oak, finished in mahogany and the plates very thick and will give a steady discharge over a long period. No premiums, just good honest battery value.



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2 Volt for W. D. 11 and 12	$4.00	6 Volt 60 Amphr.	$ 7.50
4 Volt for U. V. 199 Tubes	7.00	6 Volt 80 "	8.50
RADIO B. STORAGE Glass Jars, Heavy Plates— Case of 12 Cells 24 V.	4.90	6 Volt 100	10.00
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Get Yours Today—NOW—Send No Money

The batteries are fully guaranteed in writing and shipped subject to examination on the day your order is received. You pay on delivery or deduct 5 per cent if full cash accompanies order. You may deduct 10 per cent if two or more are ordered at one time.

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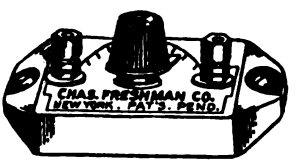
FRESHMAN

Variable Grid Leak

and condenser combined



Accepted the World Over as the

STANDARD UNIT for EVERY TUBE SET

It is the most compact; the most efficient; the most readily adapted to ALL grid circuits and the only one which is entirely sealed and always remains unaffected by any climatic conditions. It is the

ORIGINAL VARIABLE GRID LEAK

and although it has been steadily improved and made better there never was a time when it was not the

BEST ON THE MARKET

Complete with either .00025 or .0005 Freshman Condenser . . **$1.00**

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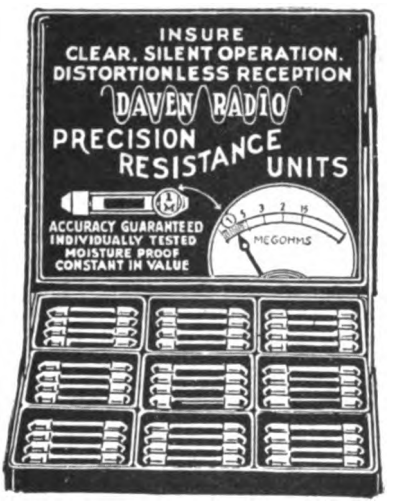
At your dealers, otherwise send purchase price and you will be supplied postpaid.

Chas. Freshman Co. Inc.
Radio Condenser Products

106 Seventh Avenue New York



PRECISION RESISTANCE UNITS

Amateurs and Radio Engineers who have experimented in the building of Radio Receiving Sets have found that the RADIO RESISTANCE UNITS are unexcelled. They positively insure quietness and pure tone reception—for satisfaction sake try one and note the difference in the purity of the tone reception in your Radio Outfit.

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Radio Resistor Specialists

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Just Off the Press!

Popular Radio's New Book "How to Build Your Radio Receiver"

The most complete and authoritative collection of material yet published in book form on how to build and operate various types of radio receiving sets

POPULAR RADIO'S new 96-page handbook, edited by Kendall Banning and Laurence M. Cockaday, is now ready for delivery. For a limited time only, as an introductory offer, it will be *given away free!*

There has long been a need for such a book as this, describing fully and completely the several different types of radio receiving sets which have proved most effective, and *how to build them.*

POPULAR RADIO'S new book, "How to Build Your Radio Receiver," has been carefully planned to fill this need. No pains have been spared to make this book the most comprehensive and valuable contribution of its kind ever published for the radio enthusiast who, with or without previous technical knowledge or training, wishes to construct a radio receiving set of his own that will meet his every requirement.

"How to Build Your Radio Receiver" gives complete specifications for the construction of *seven* separate and distinct receiving sets—covering the most amazing range and variety of circuits, from the most modern simple crystal set to the famous Super-heterodyne (see opposite page).

All working details are given—the list of parts required and their approximate cost; complete hook-ups and circuit diagrams and *how to read them;* illustrations making all points clear, and simple instructions on how to assemble, mount, wire and operate each set.

Nor have any helpful pointers been omitted. In this new book edited by Mr. Banning and Mr. Cockaday, you will also find scores of valuable hints and suggestions about aerials, how to select your parts, how to install your set, tips on tuning, and how to learn the code.

In all, a book you will not want to be without—one that will be worth many dollars to you. Yet, if you act at once, it will not cost you a penny. We will send you a copy of this valuable handbook absolutely free with a year's subscription to POPULAR RADIO at $3.00. If you are already a subscriber, you may renew or extend your subscription for an additional year and still secure one of the first copies of this valuable book *absolutely free.*

The Coupon printed at the bottom of the opposite page provides a convenient means for you to secure one of the first copies of this handbook free. But you must act at once!

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Seven Remarkable Receiving Sets

Illustrated *Diagramed* *Described*

EACH of the sets described in POPULAR RADIO'S new book has been selected as the most *ideal* of its kind—for distance, selectivity, tone, volume, simplicity of construction, ease in tuning, reliability and general all-around satisfaction.

You will find sets employing both crystal and vacuum tube detection, with regenerative amplification, audio-frequency amplification, "push and pull" power amplification, radio-frequency, *compensated* radio-frequency and *intermediate wave* radio-frequency amplification.

You have your choice of crystal, one-tube, three-tube, five-tube, six-tube or eight-tube sets—the broadest selection anyone could ask for, all clearly illustrated, charted and explained in the simplest possible terms.

Here are the actual receiving sets described in this new book, "How to Build Your Radio Receiver":

A $5 Crystal Set

The simplest up-to-date set for local broadcast reception. Approximate range, 15 miles, though distances up to 400 miles are not extraordinary. Gives clear signals on headset without distortion. No operating cost whatever.

The Haynes Single Tube Receiver

An efficient set that may be made by a novice at an approximate cost of only $15 for parts. Simple to tune, selective, good audibility. Long distance range up to 1,000 miles on earphones. Six-volt storage battery and 22½ volt "B" battery required, or may be adapted for dry cells and dry cell tubes.

A Two-Stage Audio-Frequency Amplifier

This instrument may be added to *any* set, crystal or tube, to strengthen the received signals so that they will operate a loud speaker. It is easy to construct, efficient, and costs only about $15 for parts. Operates on the same "A" battery that is used on the vacuum-tube detector unit.

The Cockaday 4-Circuit Tuner

A 3-tube set, famous for its high selectivity and beautiful tone. So neat and compact that it may be kept in a bureau drawer. Cost of parts about $40. Receiving range approximately 1,500 miles on a loud speaker. Operates on 6 volt storage battery and two 45-volt "B" batteries, or may be adapted to dry cells and dry cell tubes.

A 5-Tube Tuned Radio Frequency Receiver

Two stages of tuned radio-frequency amplification, detector, and two stages of audio-frequency amplification are here employed so that the possibility of "oscillation and re-radiation" is eliminated. The set can be operated on a loop antenna and may be built at a cost of only $90 for parts. Six-volt storage battery and two 45-volt "B" batteries required. Range about 1,000 miles on loop or indoor antenna, and 2,500 to 3,000 miles on an outdoor antenna.

The "Improved" Cockaday 4-Circuit Tuner

Probably the most important contribution yet made to the equipment of the radio fan. A compact 5-tube set with a receiving range of over 3,000 miles. Cost of parts about $95. Wave lengths range from 150 to 675 meters. Automatic tuning and power amplification. Maximum volume of sound, excellent reproduction and no interference. Requires a 6-volt "A" battery, three 45-volt "B" batteries, one 22½-volt "B" battery and a 9-volt "C" battery.

The Regenerative Super-heterodyne Receiver

More sensitive, more selective and more simple to tune than any other 6-tube receiver yet developed. A three-section, 6-tube set employing the Haynes Single Tube Receiver as tuner. May be further extended to a four-section, 8-tube set by the addition of the two-stage audio-frequency amplifier. The cost of parts approximate $100. Range of 3,000 to 4,000 miles on a loud speaker. Has been called the "Rolls-Royce" of radio receivers.

¶ As a special introductory offer, for a limited time only, this book will be given FREE with a year's subscription to POPULAR RADIO at $3. Simply mail your remittance with the handy coupon below, and a FREE copy of "How to Build Your Radio Receiver" will be sent you, postage prepaid. Your subscription will be entered at once.

Radio Dealers and Jobbers: Write for Our Special Letter 23AA, of Particular Interest to You.

This Coupon Entitles You to a Free Copy

POPULAR RADIO, Dept. 25,
9 East 40th Street, New York City.

Please send me, postage prepaid, a FREE copy of POPULAR RADIO'S new handbook, "How to Build Your Radio Receiver," edited by Kendall Banning and L. M. Cockaday. I enclose $3 for a year's subscription to POPULAR RADIO which entitles me to this book absolutely free of charge.

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N R E

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For all-around efficiency in actual performance we back our "Hegehog" to the very limit. Put it in comparative tests with any transformer made. Install it in any of the latest hook-ups—Neutrodyne, Autodyne, Superdyne, Miloplex, Autoplex. Judge it for volume, tone quality and consistent performance. Give it every possible test. Then consider its size and price. If you do not find the "Hegehog" unsurpassed in every way, your money will be gladly refunded. We guarantee it unconditionally. There is nothing superior to the "Hegehog" in efficiency and for compactness. Make this test. Send for FREE Bulletin No. 92. Ratios 1 to 3, 1 to 4, 1 to 5—$3.50; 1 to 10—$4.50.

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3807 Ravenswood Ave., Chicago

AUDIO TRANSFORMER

$3.50

"HEGEHOG" TRADE MARK

Cut ¾
Actual size

Guaranteed Head-Sets

"RED-HEADS" are *guaranteed* radio phones. You run no risk when you buy them. Money back if, after 7 days' trial, you're not satisfied that they're the *best* receivers on the market at the price. Why not act *right now* and get a pair? It'll mean getting the *maximum* from broadcasting from the day you put them into use.

RED-HEAD RADIO RECEIVERS

NOW READY

The new 1924 Model F $6.50 Per Pair Complete | The new "Red-Head" Jr. $5.00 Per Pair Complete

"Red-Heads" sent prepaid on receipt of price if you are unable to get them at your dealer's.

The NEWMAN-STERN COMPANY
Dept. PR Newman-Stern Bldg. Cleveland

The TRINITY LOUD SPEAKER

TYPE AI
$25.00
21" Fibre Horn

The Trinity Loud Speaker is an instrument that combines the best qualities of a phonograph reproducer in combination with electro-magnetic principles best fitted for radio amplification.

Perfect reproduction of all music and speech without distortion. No storage batteries required. The instrument is of a heavy duty type and is guaranteed fully by the manufacturers.

For sale by good dealers. Literature upon request.

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YOU DON'T NEED TUBES

To hear concerts from distant Cities.

YOUR CRYSTAL SET

will bring them in if you follow my instructions. You may already have all the parts you need and merely have it HOOKED UP WRONG.

People using my plans hear programs clearly from stations

400 TO 1000 MILES AWAY

No TUBES, BATTERIES, AMPLIFYING APPARATUS or Special Crystal required. My COPYRIGHTED instructions selling for $1.00 are written so anyone can understand. They show you exactly how to fix the set you have or make one like mine.

Satisfaction Guaranteed or money refunded.

Send self-addressed envelope for picture of my set and further particulars. Write me today.

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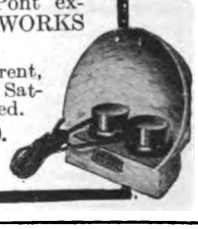
NEW PYRALIN SHELTONE LOUD SPEAKER $3

Made by Du Pont expressly for us. WORKS with any Phones.

Beautiful, transparent, exceptional value. Satisfaction guaranteed.



THE SHELTONE CO.
185-189 Clinton Ave.
Newark, N. J.

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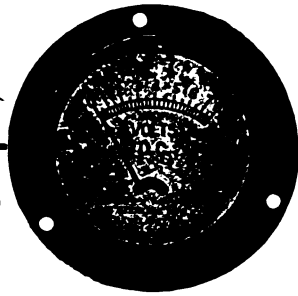

$4.00 $4.00

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Sterling

FILAMENT METER

Avoid a burn-out of your vacuum tube by knowing the voltage conditions with a Sterling Filament Voltmeter. Another advantage is the ease in duplicating results and quick tuning. Sterling Filament Meters are of the magnetic type, flush-mounted, always reliable and make a very attractive addition to any radio panel.

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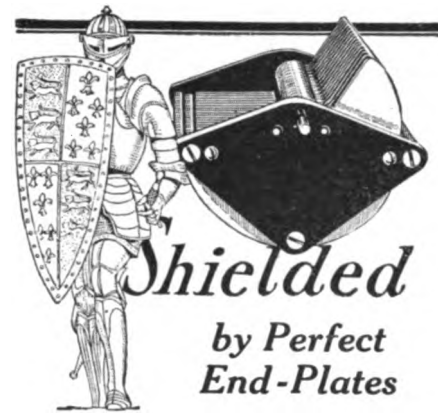

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by Perfect End-Plates

U.S. TOOL CONDENSERS

Infinitesimally small dielectric losses in *U. S. Tool Condensers.* The end plates of *Laminated Condensite-Celeron* are non-porous, proof against all capacity leaks and non-warping. One of the details that make it well worth your while to insist upon *U. S. Tool Condensers.* Write for booklet.

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116 Mechanic St. Newark, N. J.

Grewol Detector

Fixed Adjustment

Don't lose patience! There is a really efficient crystal detector — the GREWOL. Fixed on the most sensitive spot.

Best for reflex circuits and crystal sets. *Guaranteed not to burn out.*

At your dealer's or direct upon receipt of

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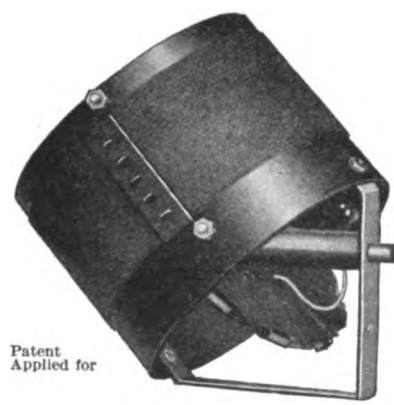
HARTMAN



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$4.50 VARIOCOUPLER $4.50

Here is a distinctively high grade Variocoupler at an exceptionally low price.

Check the following points and verify this claim.

(1) Spider web rotor. The only means of obtaining minimum coupling. (2) Pig tail contacts. (3) Bakelite tube. (4) Green silk wire. (5) No live brackets. (6) Improved taps. (7) Dead shaft and no capacity effect in tuning. (8) 180° dial adjustment without the rotor being submerged in stator field.

THE HARTMAN ELECTRICAL MFG. CO.
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Glance over this broad list of radio parts and equipment that you can secure FREE, merely by introducing POPULAR RADIO to some of your friends and acquaintances who will appreciate the opportunity of subscribing to this most interesting and helpful magazine.

Show this copy of POPULAR RADIO to other radio fans. The pages of the magazine will speak for itself. Then send us the names of your friends, with $3 for each yearly subscription, and take your choice of any of the following premiums. They'll come to you *absolutely free.*

Any One of These for 2 Subscriptions:

Dubilier Ducon, and choice of any *three* Dubilier Micadon Grid Condensers of the following capacities: .00025; .0005; .001 or .002.

Pudlin Tubular Grid Leak (2 megs.); Dubilier Micadon Grid Condenser .00025; Cutler Hammer 6 ohm Rheostat, and *one* Alden Napier Socket, choice of either 201A or WD-11.

Three Pacent Jacks (*one* single circuit and *two* double circuit).

Bakelite Panel, size 7 x 18 inches.

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One copy of Ballantine's "Radio Telephony."

Cutler Hammer 30 ohm Rheostat and choice of *one* Alden Napier Socket: 201A, 199 or WD-11.

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Your Choice for Only 3 Subscriptions:

Bakelite Panel, size 7 x 24 inches.

Set of Mounted De Forest Coils; 35, 50, 75.

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Two Cutler Hammer 6 ohm Rheostats and *one* Cutler Hammer Potentiometer.

Diode Dry Cell Tube and Cutler Hammer 6 ohm Rheostat.

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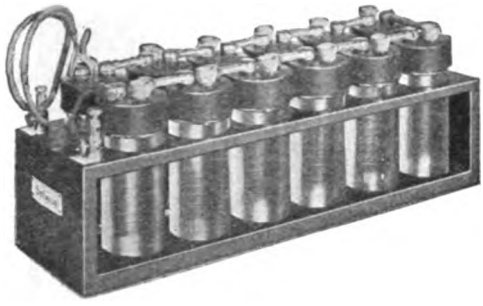

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Absolutely Quiet *Dry* Charged

The Seneca 24 Volt Radio B Battery is designed and constructed for *long life, absolutely quiet and uninterrupted service*, its separate cell assembly prevents current leakage common to other types. Seneca Batteries are shipped DRY with FULLY CHARGED PLATES and are ready for service immediately after addition of acid, without initial charging. They guarantee successful RADIO OPERATION. Send for yours today, if not satisfactory, return in 30 Days and money refunded.

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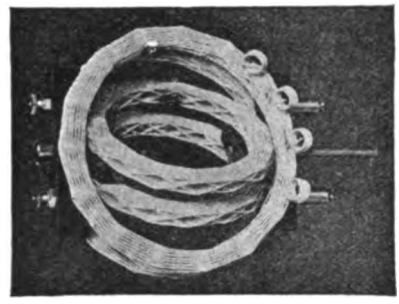
1525 Main Street - - Buffalo, N. Y.



Diamond Weave Variocoupler
An R. M. C. Product

Seven-eighths of windings are in mid-air, thus reducing dielectric losses to a minimum.

Diamond Weave Construction reduces distributed capacity to a minimum.

The R. M. C. Variocoupler has a wave range of 150 to 600 meters. The Variometer is the same size and general construction as the variocoupler, and has a variance in inductance of 300 meters.

Outside diameter of primary windings is 4⅛"; of secondary, 3¼"; extreme length 5¼".

These R. M. C. products will greatly improve any circuit where a variometer or variocoupler can be used.

Variocoupler.....$4.50
Variometer.....$4.50

THE RADIO MANUFACTURING COMPANY
of Springfield, Massachusetts
Dept. B **97 Dwight Street**

FOUR CIRCUIT COIL SET

$2.50

"A" Coil covered square wire.

"D" Coil bank wound.

Full set A, B, C and D coils made exactly according to Cockaday's specifications. Full size blue prints and illustrated instructions with each set.

Materials for standard Four Circuit Tuner—panel, coils, condensers, verniers, grid leak, vernier rheostat, socket, jack, dials, switch, contacts, posts, busbar wire, spaghetti, etc. (no tubes or phones).

Complete for $11.65

NEW TYPE COILS
For improved Cockaday Tuner—double silk covered wire wound on hard rubber or bakelite tubes. **$4.00 per set**

Postage additional on all orders
Send no money. Order by post card, pay the postman.

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LOUD SPEAKER $18.50 **HEAD SET $4.50**

"ROYALFONE"
KING OF ALL

A complete loud speaker of superior qualities. Will reproduce music or speech with no distortion.

No extra batteries required. Will operate at one or more stages of amplification.

Comes complete with 6 foot cord. 24" high—14" bell—Crystaline Finish

Loud Speaking Unit with special phonograph attachment $8.00. Can be attached to any horn or phonograph arm.

We are the makers of the "Royalfone" King of All headsets at $4.50.

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Royalfone
KING OF ALL

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Clear and Sweet

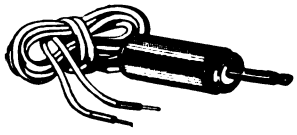
You've tried many expensive tricks to improve reception on that set of yours, but do you know that for the cost of one necktie you can get real results?

The ORIGINAL

COMSCO COMSCO COMSCO

AUTOMATIC BULL DOG GRIP PLUG

(Licensed Under Pat. Pend. Serial No. D 8010—No. 578540)



IS THE LAST LINK IN PERFECT RECEPTION

The COMSCO AUTOMATIC BULL DOG GRIP PLUG is very simple to operate. Connecting tips are inserted by a single touch, while with the flip of a small knob the tips slide out easily.

WE GUARANTEE THAT THIS PLUG saves you from short circuits and battery kicks. No more burned out phones or ruined transformers. No more broken finger nails.

For one pair phones $1.00
For two pair phones $1.50

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And it's easy to get such goods—anything you want in radio equipment. Big complete stock—everything guaranteed; quick service; right prices. And you're *sure it's reliable* when it comes from Andrae. Get our complete catalog—free

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ANDRAE *In Business Since 1860*

"Push-Pull" Amplifying Transformers

Amplify the MODERN Way

The "Push-Pull" method of amplification is the latest and best method. Used in addition to one or two stages of audio. Latest bulletin, hook-up and complete information on request. MODERN Transformers can be used with all standard tubes.

Modern 10 to 1

This type is of particular value in the new Reflex circuits where a higher secondary reactance helps maintain the equilibrium in the circuit necessary for effective operation. The audibility amplification curves of these transformers are practically flat.

Modern 4 to 1

This type is especially recommended for the most satisfactory operation in a 2-stage amplifier, using either two 4 to 1 Transformers or a 10 to 1 on the first stage and a 4 to 1 on the second stage. This latter arrangement yields greater volume.

The Modern Electric Mfg. Co.
Dept. 702 Toledo, Ohio

MODERN TOLEDO

LOUD SPEAKING CRYSTAL SET

Stations brought in from over 1000 miles and music heard all over the room right from your present crystal set with the STEINMETZ AMPLIFYER. Get our complete catalog.

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Are You the Boy We Want?

We're looking for a few live wires, real "go getters," who can earn good "jack" in their spare time, taking subscriptions to POPULAR RADIO. Commissions in cash. Profitable and enjoyable work. Easy as "falling off a log."

$31.50 in 2 Weeks

is the record of a Philadelphia lad—one of our part timers—whose motto is "Do it now, and bring home the bacon." Want me to prove to you that *you* can do it too? All right! Here goes—just fill out the coupon—and "let George prove it!"

Popular Radio, Inc., Dept. 28
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C'mon George! Whatcha got up your sleeve? Tell me how I can make some extra money working for good old "Pop" Radio, in my spare time, and send me a sample copy free.

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SMALLEST LOOP ANTENNA

All the well known advantages of the loop aerial are intensified in the *Warren Radio Loop.* So small you can slip it into a coat pocket, yet as sensitive as a much larger outside aerial with all its defects. Absolutely accident proof. Write for the name of the nearest Warren dealer and our Bulletin containing latest hook-ups, TODAY.

Type A-727 (800-700 meters) 6 inches square—non-directional.....$10
Type A-7230 (175-1000 meters) 6 inches square—non-directional.....$12
Type B-2827 (800-700 meters) 18 inches square—directional.....$20
Type BL-2820 (200-18,000 meters) with honeycomb coil mounting. 18 inches square—directional.....$25

Send for Bulletin I-102

V-DE-CO RADIO MFG. CO., Dept. F. Asbury Park, N. J.

$8

A phone plus a ***FIBERTONE*** *makes a beautiful musical instrument*

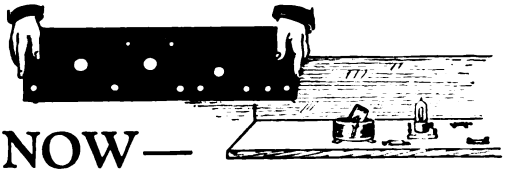
The highest tonal quality undisturbed by either metallic noises or distortion is best obtainable with a fiber horn. This one factor is the reason for Fibertone's popularity. And the low price for such fineness is a sensation of the radio world. The beautiful crystalline finish of the Fibertone fits it for any place where the finer things of the home are seen.

If your dealer cannot supply you write direct.

FIBER PRODUCTS COMPANY
34 Orange St. Bloomfield, N. J.

FIBERTONE

RADIO HORN



NOW— panel right!

YOU have completed experimenting. You are satisfied at last with your hook-up. *Now*—panel it so that it will look well as well as work well! Have handsome, durable sides and top cut from this matchless material—

bakelite-dilecto

(A Laminated Phenolic Condensation material)

Withstands amazingly every kind of radio abuse. Unaffected by heat, cold, water, oil, steam, solvents and weather conditions. Highest in dielectric strength. Ask any radio dealer to obtain it for you, cut and drilled.

THE CONTINENTAL FIBRE CO.
Factory: Newark, Delaware

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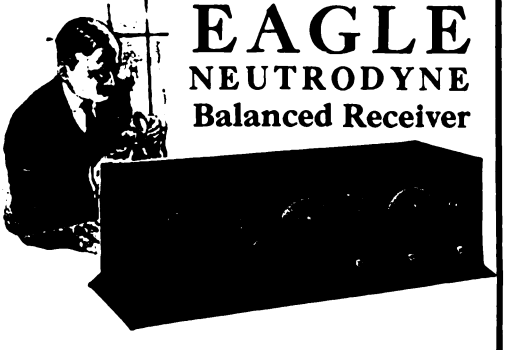

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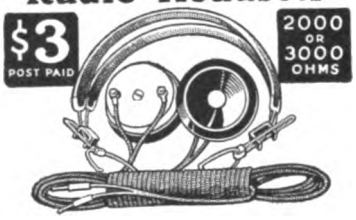

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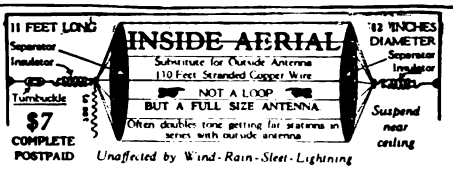

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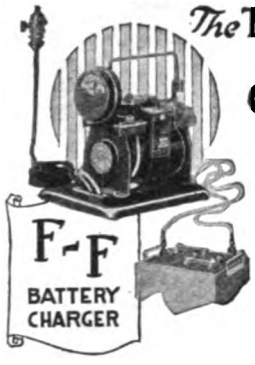

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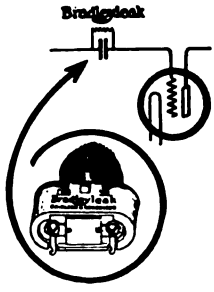

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Is Your Grid Leak Correct?

The following table gives the approximate values of grid leak resistance recommended by vacuum tube manufacturers:

Audion (DeForest) DV-6,	2 Megohms
C-200	2 Megohms
C-299	2 to 5 Megohms
C-301-A	2 Megohms
UV-199	2 to 5 Megohms
UV-200	2 Megohms
UV-201-A	2 Megohms
WD-11	3 Megohms, or more
WD-12	3 Megohms, or more

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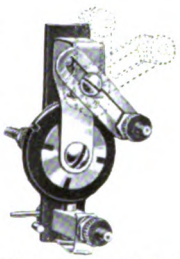
This Little Box Brings Maximum Efficiency to Your Receiving Set

Since the Cutler-Hammer Engineers announced the C-H Variable Grid Leak, thousands have learned the secret of grid control. This little instrument makes it possible for the grid condenser to discharge at just the proper rate for maximum reception, and is built with watch-like precision to give perfect results. It is quickly installed in any set without additional wiring—the short link to the grid post (adjustable to any position) assures maximum efficiency and the long insulated shaft makes adjustment from the front of the panel easy and accurate.



The C-H Variable Grid Leak is fully adjustable to care for any grid condenser.

Put one in your set today! But insist on the C-H trademark and the orange and blue carton, for the grid circuit is the most delicate in your set and only the most precise instruments can be used with safety. Here the faint electrical pulsations are brought direct from the aerial to start through the process of amplification that finally makes them powerful enough to violently vibrate a "loud speaker" diaphragm. False fluctuations induced by poorly constructed or improperly designed apparatus are magnified thousands of times. Insist on the grid leak by the "Master Builder" and be certain of success. Sold by dealers everywhere.

The C-H Variable Grid Leak is mounted on the grid post—where it belongs. This allows a short grid lead for maximum efficiency and the long insulated shaft to the panel prevents "body" noises.

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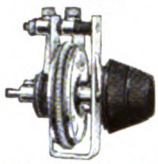
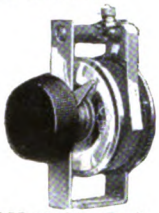
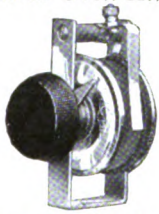


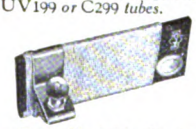
The C-H 4 Ohm Vernier Rheostat—*Perfect detector tube control. Also furnished without vernier for amplifier tube control.*



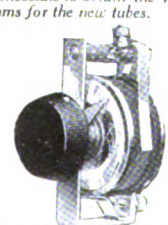
The C-H 30 Ohm Radio Rheostat—*For control of the ¼ ampere, "UV201A-C301A" type receiving tubes and the "UV199-C299" type.*



The C-H 125 Ohm Radio Rheostat—*The rheostat that makes it possible to use a 6V storage cell with the UV199 or C299 tubes.*



The C-H Variable Resistance Unit—*Attach it to your present 4 ohm rheostats to obtain the required 30 ohms for the new tubes.*



The C-H Radio Potentiometer—*The potentiometer with the resistance unit that does not wear and cannot be displaced under constant usage.*

C-H *Variable* GRID LEAK

PRESS OF WILLIAM GREEN, NEW YORK

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A Radio Statement to the Public

KEEPING its pledge to the public, the Radio Corporation of America has concentrated its vast research and engineering forces upon the solution of certain fundamental problems facing the art—problems which have become more apparent as broadcasting stations and radio receivers multiply.

The phenomenal expansion of the radio industry, and the universal and ever-increasing appeal of radio represent an outstanding development of the present century—for this industry has grown from infancy to maturity in a space of but two years.

• • •

Briefly stated, there is today a necessity for

—*A radio receiver providing super-selectivity*—the ability to select the station you want—whether or not local stations operate. A selectivity which goes to the theoretical limits of the science.

—*Super-sensitiveness*—meaning volume from distant stations—along with selectivity.

—*Improved acoustics*—more faithful reproduction of broadcasted voice and music than has ever been possible before.

—*"Non-Radiating" receivers*—a new development—a type of receiver which, no matter how handled, will not interfere with your neighbor's enjoyment.

—*More simplified operation*—a super-receiver requiring no technical skill, thus making the greatest achievements of entertainment immediately available to all members of the family.

—*A receiver for the apartment house* populated districts, requiring neither nor ground connection.

—*Another type of improved receiver the suburban districts*, equally capable that above, for use where the erection an aerial presents no problem.

• • •

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First—that improved acoustics are possible—a matter of scientific research and not of haphazard design—for truly melodious reception.

Second—that dry battery operated sets can be so designed as to give both *volume* and distance.

Third—that the regenerative receiver is susceptible to marked improvement providing selectivity, sensitiveness and simplicity of operation hitherto deemed impossible of accomplishment.

Fourth—that the Super-Heterodyne—the hitherto complicated device requiring engineering skill to operate—could be vastly improved—improved in sensitiveness and selectivity—and simplified so that the very novice and the layman could enjoy new realms of entertainment and delight.

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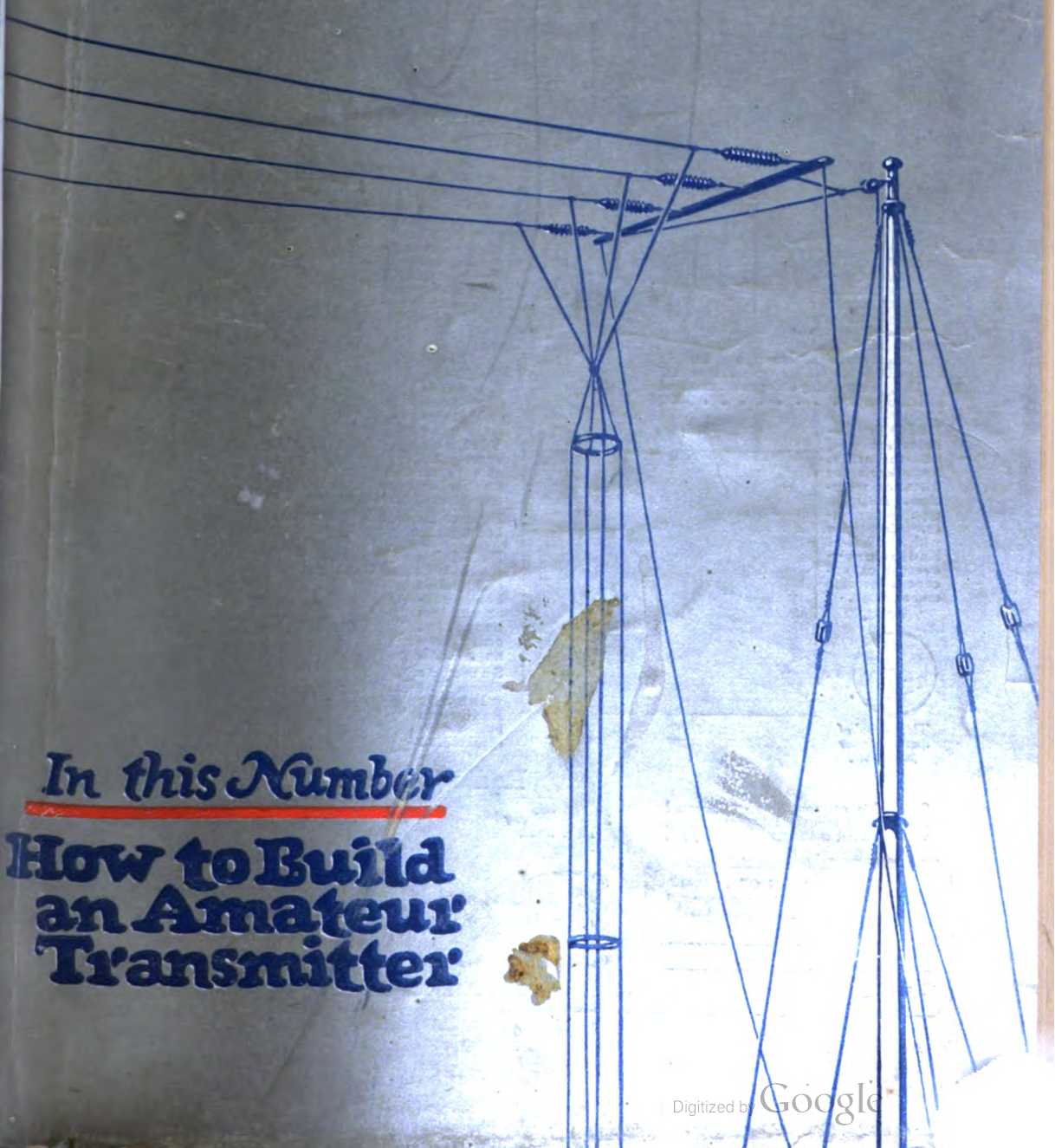

In this Number

How to Build an Amateur Transmitter

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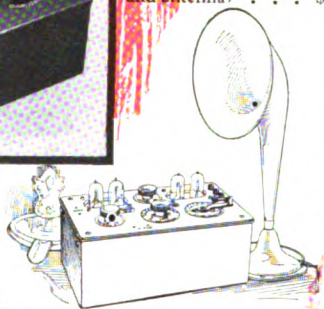
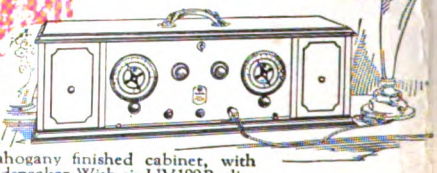
Radiola III, an improved two tube receiver of antenna type, sensitive and selective. *Complete* with two WD-11 Radiotrons and headphones (everything except batteries and antenna) . . . $35.



Radiola III-a, which is Radiola III and its balanced amplifier complete in one cabinet; including four WD-11 Radiotrons, headphones, and Radiola Loudspeaker (either type FH or UZ 1320.) Everything except antenna and batteries $100

Radiola Super-VIII —an improved Super-Heterodyne. Selective and non-radiating. With *no antenna,* and no ground connection, it receives far distant stations, even while local ones are operating. Loudspeaker built in. *Complete* with six UV-199 Radiotrons — everything except batteries . . . . $425.



Radiola Super-Heterodyne, same as Super VIII but semi-portable in mahogany finished cabinet, with Radiola Loudspeaker. With six UV199 Radiotrons, but without batteries . . . . $286.

Same as above, but without Radiotrons or Loudspeaker . . . . . $220.

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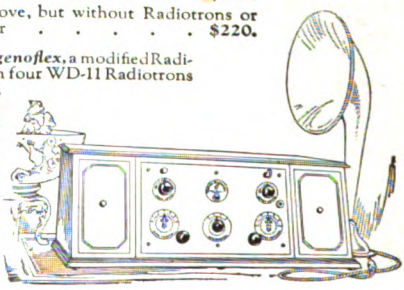
This symbol of quality is your protection.



Radiola Regenoflex, a modified Radiola X. With four WD-11 Radiotrons and Radiola Loudspeaker but less batteries and antenna . $206.

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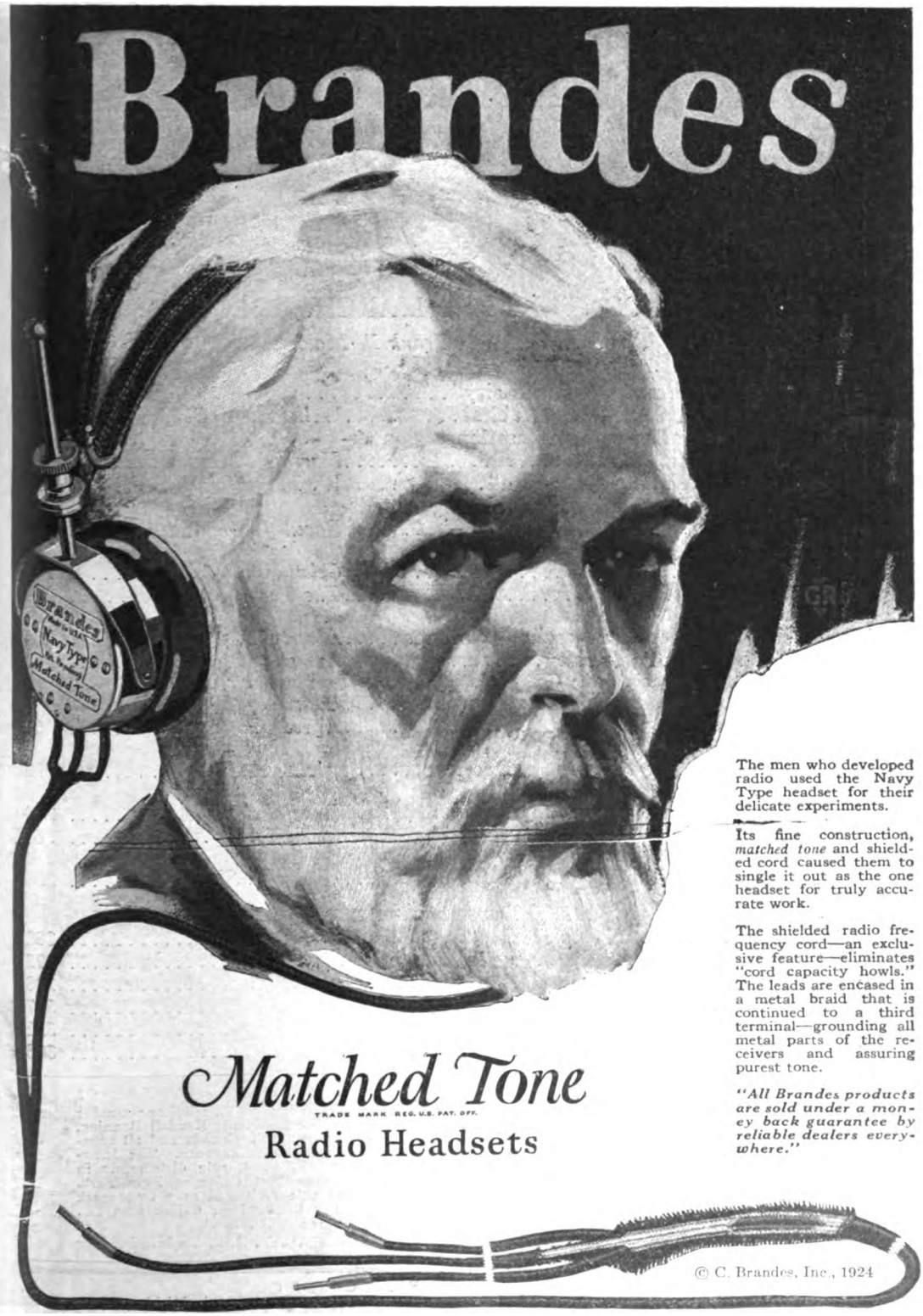

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Its fine construction, *matched tone* and shielded cord caused them to single it out as the one headset for truly accurate work.

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Radio Headsets

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POPULAR RADIO

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Doctor Hy

WHAT delight for all in the ever-fresh programs during the long, wintry evenings to come. Today's broadcasting better than yesterday's; tomorrow's more fascinating than today's. Tune in on this realm of entertainment, with a

GREBE Broadcast Receiver

Supplied in two types, each an Instrument of rich, dignified beauty—the product of more than ten years of skillful development.

CR-12 is a 4-tube Instrument in which are combined Regeneration and Tuned Radio Frequency Amplification.

CR-14 is a popularly-priced 3-tube dry cell Receiver employing Regeneration. The sockets accommodate UV-199 or C-299 tubes without adapters.

Both have beautiful walnut cabinets, employ concealed dry batteries and are extremely simple and economical to operate. Ask your quality dealer for a demonstration, or write us for full particulars.

A. H. GREBE & CO., Inc.
Van Wyck Blvd., Richmond Hill, N.Y.

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Grebe Broadcast Receiver Type CR-14. A 3-tube Receiver of exceptional value $110.00
(Accessories extra)

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PAGES WITH THE EDITOR

THE next issue of POPULAR RADIO will contain an important contribution to the art and to the practice of radio—a complete, detailed "how to build" description of the latest product of the technical staff of this magazine—a simplified and extraordinarily efficient neutrodyne receiver.

* * *

THIS new development is a non-regenerative radio-frequency set. It has been designed by Albert G. Craig, the assistant technical editor of POPULAR RADIO, with the assistance of the technical editor, Laurence M. Cockaday, the creator of the famous four-circuit tuner, or as it is now internationally known, the "Cockaday Circuit."

* * *

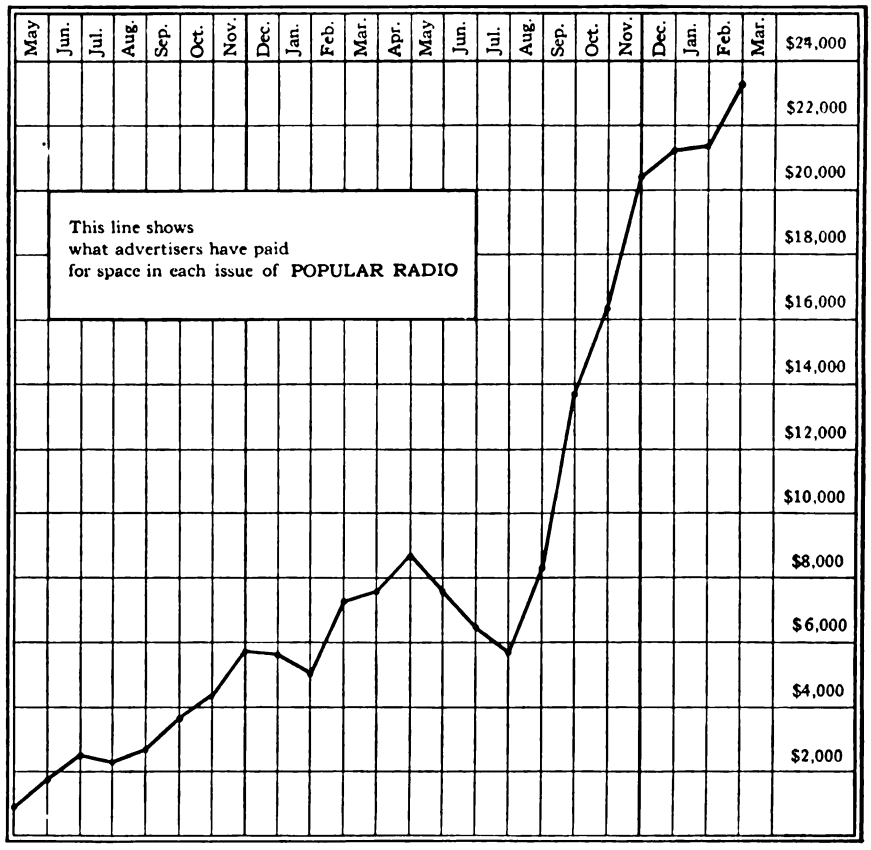
TESTS of this new receiver, which have been carried on over a period of several months, have revealed three outstanding features that will commend the set to radio fans:

1. Exceptional sensitivity for long-distance work;
2. Remarkable clarity of reception;
3. Ease of construction and operation.

* * *

IT is not at all unlikely that this new receiver will take its place with the best and most popular of the sets that have first been announced to the radio world in the pages of POPULAR RADIO; "How to Build the New Armstrong-circuit Receiving Set" by L. M. Cockaday, (September, 1922); "How to Build a Real DX Receiver" by L. M. Cockaday, (January, 1923); "How to Build the New Four-circuit Tuner" by L. M. Cockaday, (May, 1923); "How

(*Continued on page 6*)



HOW POPULAR RADIO HAS GROWN IN 22 MONTHS

Some idea of the remarkable development of this magazine since the May 1922 issue (which was the first one published) up to and including the March 1924 issue (which you are holding in your hands) may be obtained from this illuminating chart—which is one of a series that have been prepared by the business office as graphic evidence of the magazine's rapid increase in size, circulation and influence.

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The Thompson MAGNAPHONE

Conceived, designed and constructed to remedy the faults inherent to the ordinary loud speaker

The radio reproducer that permits your receiving set to perform at the best. It is ALL THERE—the volume, the quality, the control, that you've been seeking and that you haven't been able to find elsewhere—you'll notice the difference instantly, when you plug in a Magnaphone.

Cone shaped bakelized fibre diaphragm, vibrating equally over its whole area,—two-to-one driving armature, reducing the permissible air gap 50 per cent.—laminated magnetic pole pieces,—individually and together forming a structure giving results so incomparably superior as to make the Magnaphone the choice of those who demand the best.

Price $35.00

What THOMPSON Means

After 14 years experience "Thompson" means a great deal in commercial and governmental Radio Apparatus. It will mean even more in Radio for the home.

The Thompson "Neutrodyne"

The "Neutrodyne" as a type is admittedly the last word in radio receivers. The Thompson "Neutrodyne" has all the advantages of the type plus the engineering skill and experience of one of the oldest radio organizations, one which has produced a majority of the high-grade commercial and government types of radio apparatus. To hear it is to realize the great difference even in various "Neutrodyne" sets—yet the price is only $150.00

At Good Dealers Generally

R. E. Thompson Manufacturing Co.

150 Nassau St., New York Jersey City, N. J.

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(Continued from page 4)

to Build a Tuned Radio-frequency Receiver" by L. M. Cockaday, (August, 1923); "How to Build the Haynes DX Receiver" by L. M. Cockaday, (September, 1923); "How to Build the New Regenerative Super-heterodyne Receiver" by L. M. Cockaday, (November and December, 1923); "How to Build the Improved Four-circuit Tuner" by L. M. Cockaday, (January, 1924), and "How to Build a Three-tube Reflex Receiver" by Walter A. Remy, (February and March, 1924).

* * *

READERS of POPULAR RADIO will be interested to learn that S. Gordon Taylor, whose essentially practical and helpful articles have been featured in this magazine, has just joined the technical staff. Mr. Taylor started out as a real "ham" fifteen years ago, and has been a contributor to numerous publications since then. He has taken special courses at both Columbia University and New York University, and is a licensed commercial radio operator.

* * *

"WHY," asks a practical-minded reader, Mr. C. Hartz of Minnesota, "are radio circuit diagrams always drawn left-handed? Why aren't they drawn the other way around, from right to left, so that the parts are indicated as they actually go into the set?"

* * *

POPULAR RADIO wonders why, too. Certainly it would appear to be more sensible to reverse the standard arrangement, (who originated it anyhow?) and to draw the circuits "the other way around" as Mr. Hartz suggests; certainly this would seem to be a more practical plan—particularly for beginners.

* * *

THE advantages of the proposed new arrangement are obvious. A home-built radio receiver, for example, is always wired from the *back* of the set; the experimenter, therefore, has to go through the mental process of reversing the conventional diagram when he does the wiring, because the wiring progresses from the antenna and the ground connections at the right, through the tuning units to the amplifier units at the left. The conventional wiring diagram starts with the antenna and ground connections at the left, and ends up with the amplifiers at *the right*.

Why not make the diagram read exactly as it applies to the set?

* * *

THE best way to find out what the radio fans think about the proposed new arrangement of circuit diagrams is to test it out and let the fans decide for themselves. In the next issue, accordingly, the article describing how to build the new and simplified neutrodyne receiver will be illustrated with a circuit diagram that is exactly the *reverse* of the conventional—and which will indicate the various parts and connections in the order in which the experimenter actually makes use of them.

THE opinions of our readers on this innovation are cordially invited.

* * *

JUST as we burst into print with the assurance that "if you see it in POPULAR RADIO it's so" some observing reader is destined to call our attention to an inaccuracy that covers us with confusion. In justice to our readers, the only honest course is to admit the errors frankly. Here are two corrections—for which we extend thanks to the good friends who make them.

* * *

THE first comes from Harry Goodall of Chicago, who writes: "In the list of broadcasting stations on page 97 of your January issue, station KFCL is listed as *San Antonio*, California. There is no such place in the United States according to the U. S. Postal Guide. Your list is the fourth one that I have seen that has had this mistake in it. It seems to me that some stenographer made a mistake in typing the list and others have copied from that incorrect list. This station should be in *Los Angeles*, California, for it is the Los Angeles Union Stock Yards station."

* * *

THE second correction comes from Dorman D. Israel of Cincinnati, whose illuminating article "Amplification without Distortion" in the January number has attracted nation-wide attention. He states:

"In checking over the text of my article I have found one or two minor errors. On page 73, in the first column, there is an addition sign consistently omitted from the denominator of the fraction. The three equations should be

$$I_p=\frac{kE_{c1}}{R_p+R_1} \qquad \frac{E_{c2}}{E_{g1}}=\frac{kR_1}{R_p+R_1} \qquad I_pR_1=\frac{R_1\,kE_{g1}}{R_p+R_1}=E_{g2}$$

"On page 75, in the first column and third line from the picture, the text should read 'tube to negative filament, and adjust e_2 to give, etc.' At the top of the next column, the first two lines should be 'first tube to negative filament and adjust e_1 for normal plate current, etc.'"

* * *

IN response to hundreds of requests from our readers for actual-size working plans of the improved four-circuit tuner (described in our January, 1924 number), POPULAR RADIO has had prepared a full set of blueprints—including the actual-size panel pattern, the instrument layout and a picture diagram of all parts, showing the wiring. The set of three will be sent to readers, postage prepaid, upon receipt of $1.10.

Kendall Banning

Editor, POPULAR RADIO

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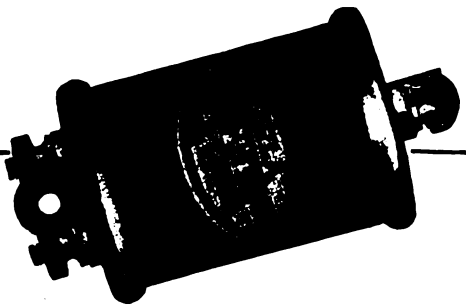
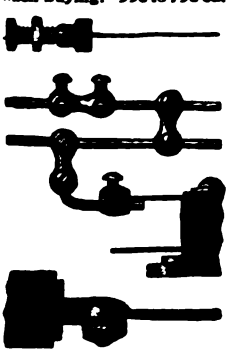
Exit Variocoupler

Enter Erla Selectoformer



Superior worth of Erla audio transformers, shown in their exclusive ability to amplify three stages without distortion, improves any set. $5

Erla condensers alone carry a certificate of accuracy on their labels. Look for the words "Tested Capacity" when buying. 35c to 75c ea.



Assembly of radio apparatus is enormously simplified by Erla solderless connectors, made in sizes and styles for every purpose. List, 3c to 5c

Combines Improved Properties of Coupler and Wavetrap

Again Erla contributes notably to radio advancement. Erla Selectoformer, replacing alike variocoupler and wavetrap, greatly increases volume and selectivity in radio receivers, at the same time reducing cost.

Selectoformer, as the name implies, operates simultaneously as a selector and transformer, picking off of the antenna the one wavelength desired and amplifying it to normal strength.

Thus is avoided the interference common to receivers that depend for selectivity upon tuning the coarse antenna system. Also, because of the amplification brought to bear, there is eliminated the loss of energy encountered in wavetraps of conventional type.

With Selectoformer, distant signals come in loud and clear, even with powerful local broadcasting in progress. Tone quality, likewise, is greatly improved, through reduction of static and other disturbances.

For complete details regarding this and other Erla improvements, including latest reflex circuits, ask your dealer for Erla Bulletin No. 20, or write, giving your dealer's name.

Electrical Research Laboratories
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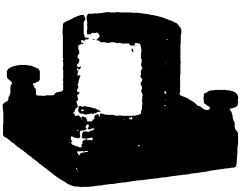
ERLA



Supreme beauty and strength are combined in Erla sockets, with heavy, nickeled shell cast into moulded Bakelite base. Many other advantages. $1

Patented telescoping rim of Erla bezels fits any ⅛" to ¼" panel, neatly screening openings required for tube ventilation. Nickel or enamel, 20c

Reliable and clear reception is assured through the Erla fixed crystal rectifier, requiring no adjustment and lasting indefinitely. List $1

Erla semi-fixed crystal rectifier enables accurate initial adjustment to individual circuit characteristics. No attention required. List $1

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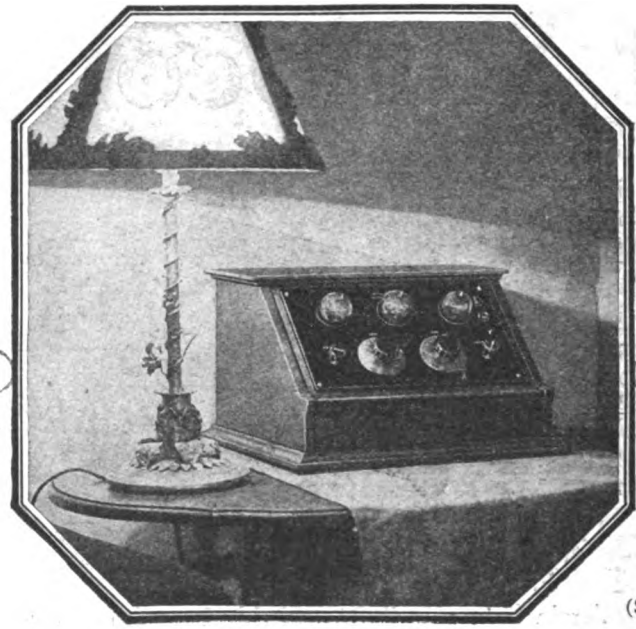

$125
fully equipped
($127.50 west of Rockies)

New Kennedy Radio Receiver, Model V

Simple to Operate—Selective—Mechanically Excellent!

This new Model V Kennedy Radio Receiver has established a high standard of tuning simplicity—combined with the same precision and selectivity formerly associated only with the more complicated Kennedy models. Added to this are all the characteristics of mechanical perfection that have made Kennedy "The Royalty of Radio."

Anyone can operate this new product of the Kennedy Engineering Staff. After a preliminary setting has been made, tuning is controlled by a single dial. Dial settings are always the same for a given station, regardless of where the receiver may be operated or the kind of antenna that may be used.

Model V is particularly free from "re-radiation." It reproduces music and voice with unsurpassed purity and operates on any ordinary antenna—outside type preferred. Embraces the entire broadcast wave range.

Selectivity is one of the outstanding features of this new Kennedy model. It will clearly differentiate between distant and nearby stations only a few meters apart—local interference can in most cases be eliminated as satisfactorily as with older Kennedy models.

Mechanically, Model V bears the same high stamp of excellence that has characterized Kennedy Receivers during the past twelve years. In every detail of construction the highest standards of precision and accuracy are rigidly adhered to.

Model V is an exquisite piece of furniture. The cabinet is of mahogany, hand rubbed to a beautiful satin finish. Its proportions are pleasing. The highly polished black Formica panel lends an elegance of finish—its height and angle have been established, after much thought and study, to provide comfort and ease in tuning.

The price of Model V, completely equipped with all tubes, dry batteries and individual Kennedy 3,000-ohm phones, with plug, is only $125.00 ($127.50 west of Rockies)—marking it as a feature value in radio equipment. Other Kennedy models range from $285.00 to $825.00 (slightly higher west of Rockies), completely equipped, including built-in loud speaker.

See the new Kennedy Model V at your dealer or write us direct for fully illustrated literature on this and other Kennedy Radio Receivers.

All Kennedy receiving sets are regenerative.
Licensed under Armstrong U. S. Patent No. 1,113,149.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS SAN FRANCISCO

KENNEDY

The Royalty K *of Radio*

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From a photograph made for POPULAR RADIO

"A Remarkable Achievement," States One of the World's Great Scientists

"I CONGRATULATE all wireless workers on the fact that in POPULAR RADIO they have a publication which is absolutely independent of all commercial interests. This means a great deal in these days of propaganda. As a rule, I do not read many of the so-called 'popular articles,' but yours are so up to date and so authoritative that I am very glad indeed to get them, and the fact that they are so lucid that anyone can understand them without previous technical training is a remarkable achievement in your field of work."

—REGINALD A. FESSENDEN

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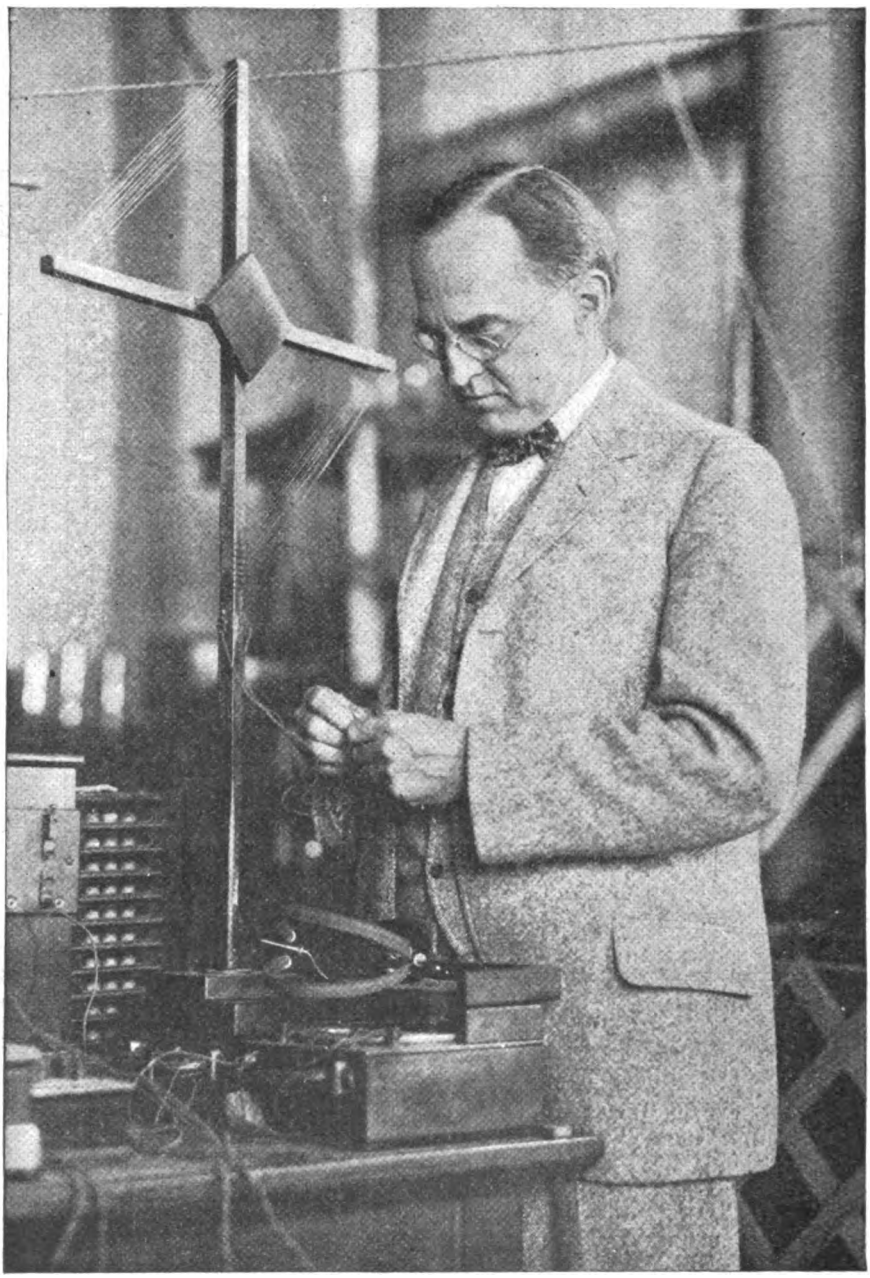

"Radio, the Open Sesame of Electricity"

So states Dr. Willis R. Whitney—and few authorities are better qualified to say what mental habits are necessary for a scientist. Dr. Whitney used to be a professor in the Massachusetts Institute of Technology; during the War he was a member of the Naval Consulting Board; now he is the head of the great research laboratories of the General Electric Company at Schenectady. In the article (beginning on the facing page) he points out what these habits are and how radio is helping to develop them in American young men.

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Popular Radio

VOLUME V, MARCH, 1924 NUMBER 3

Is Radio Changing Our Mental Habits?

While the amateur is experimenting with his set he is acquiring something more than a mere technique; *he is learning how to think*—and learning in a way that is significant both to him and to the world of science.

By WILLIS R. WHITNEY, Ph.D.

TO a man whose business is scientific research one of the most important features about radio is its promise as a training school for future scientists.

The high-school boy who has been experimenting for a year or two with home-made radio sets probably has already a better working knowledge of electrical science than was possessed by the average college graduate of twenty years ago. He has awakened a wide group of scientific interests. He has acquired, almost unconsciously, many of the essentials for a life of useful scientific research.

This seems to me a fact of extraordinary social and economic importance. We want America to go ahead. We want our industries to prosper and the inventiveness for which our countrymen are famous to continue. And we want the world to become a better place for our having taken a part in it.

This means that we must have much scientific research—even more research than we are doing now. It means the continual study of scientific problems carried on in hundreds of laboratories; sometimes because of definite industrial needs; more often, perhaps, because of love of knowledge for its own sake. It means, too, that we must provide a continual supply of men who are competent to do this work; men who are not only trained in the *facts* of science, but who have that equally necessary asset of inquisitiveness, who possess the undimmed curiosity and lively imagination of those on whom the shackles of established precedent have not yet been fixed.

If I were asked to set down what seems to me the most important single asset of a scientific research worker, I would say, I think, that it is just this attitude of free inquisitiveness, this willingness to start off into new lines of

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thought that no one has ever followed before.

Think, for example, of the history of the transmission of speech over long distances. The first effort to do this, I suppose, was by finding men who could shout loudly, or by lining up a number of such men, and having them all shout at once. This way of doing it is still used, we are told, by some savage tribes. Other savages use drums or gongs. Travelers report that messages can be sent long distances in the African jungles very quickly by being relayed in this fashion from one drum-telegraph station to another.

Gilliams Service

AN INTEREST IN RADIO DEVELOPS INGENUITY

Experimenting with radio taught this New York fan, Mr. Henry Farkouh, enough inventiveness so that he built this entire receiving set, containing three tubes, tuners, batteries and all, on a belt that he can fasten around his waist. The antenna wires are rolled up when not in use.

Civilized men, some thousands of years ago, began a somewhat different improvement, the speaking tube. By confining the sound of the voice in such tubes, it was possible to transmit it through walls or over distances somewhat greater than could be covered by a mere shout.

Now all these devices—the man who could raise a loud shout, the beaten drum, the speaking tube, and (I might add) the modern megaphone—are perfectly natural extensions of ordinary speaking. It required no great inventive genius, no really new thinking, to devise these things.

But the next step *did* require new thinking.

If you wanted to work a speaking tube over a longer distance than usual, your natural thought would be to make the tube larger. But this was not, as it proved, the actual path of advance. What was really done, was to make the tube *smaller;* to make it so small, in fact, that the tube part of it disappeared entirely and it became a wire. Then speech was sent through this wire in a totally new way, an electrical way. It became the telephone.

The point of this is that the invention of the telephone came through a new way of thinking.

Progress along the old lines of thought, the attempt, that is, merely to improve the speaking tube, would never have got us anywhere. Some one had to break away altogether from this usual way of thinking and start out in a new way.

Every once in a while this has to be done in any line of research and here is where the real research man proves his worth. He is the man who can escape from precedent and who has new knowledge, often before he has the problem, or who can attack whatever problem confronts him in a totally new way.

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Bureau of Standards

SCIENTIFIC RESEARCH THAT ANY RADIO FAN CAN DO FOR HIMSELF

Radio not only trains a man for scientific work, it gives him many opportunities to do valuable research for himself. With portable loops and accessories (such as this outfit of the Bureau of Standards) any radio amateur can make valuable observations on the behavior of radio waves in the ether; on the effect of buildings, mountains and other obstacles on transmission; and on many similar problems the true solutions of which are still unknown even to the scientists.

Scientific research might be defined as the continual search for the unexpected, the continual possibility of doing what was believed to be impossible—not only not considered possible, but frequently not even considered *at all* because at the time it was impossible to consider.

The young man who enters science by the path of radio is exceptionally likely, I think, to retain this desirable open-mindedness and freedom from the rule of precedent. Most of the facts about radio have no precedents. Many of them are still unclassified or poorly understood and it is just such unclassified facts in all branches of human knowledge which are the most interesting and which give us, when they are followed up, the most fruitful scientific advances.

The development of the vacuum tube, for example, involved more than a score of inventions that were once considered to be hopelessly impossible. The chief of them perhaps was ductile tungsten. When Dr. Coolidge was trying to work this out most of the scientific men in the world thought that we were following a foolish dream. Tungsten, they said, was by its very nature a brittle metal. The system of academic pigeonholes had no place for a kind of tungsten that could be drawn into wire; therefore, no such metal could exist. This was the attitude, it usually is the attitude, of the conventional mind.

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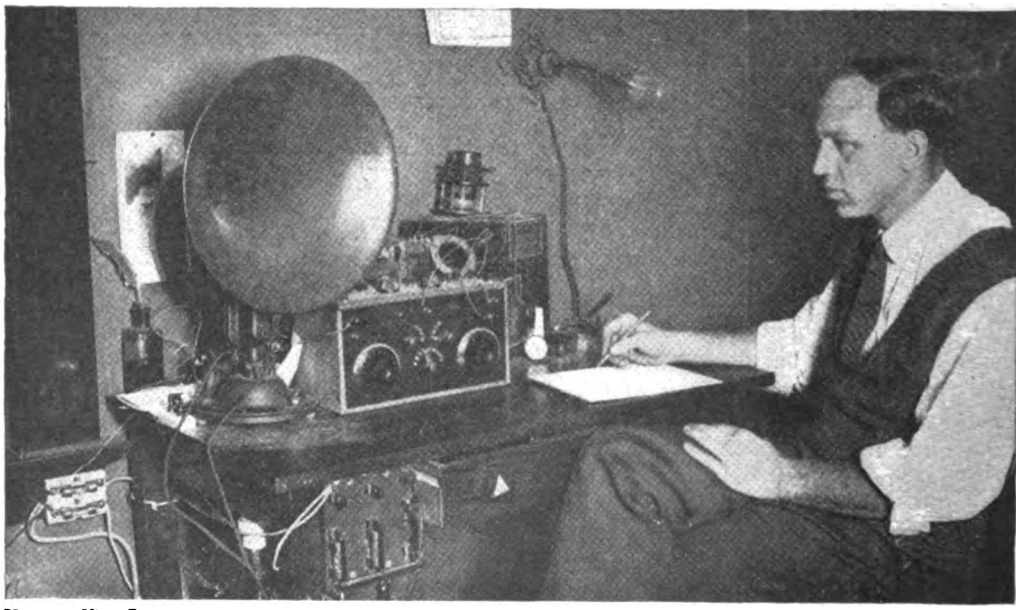
But ductile tungsten was made to exist and Dr. Coolidge found out how to make it. The result was the modern electric lamp and, more recently, the radio vacuum tube. Without a willingness to think along new lines in spite of supposed impossibilities this would never have been done and today's broadcasting might have had to get along without the vacuum tube, if, indeed, it could be done at all.

The daily history of radio is full of similar instances. Even the receiving of broadcast concerts is encouraging, I think, to a habit of open-mindedness. Tuning in on a distant station is a good deal like hunting for an unknown scientific fact. You have the conviction that the fact is there, you enjoy immensely the uncertainty and suspense as you try to find it. Finally you have the thrill of picking up out of the ether the tones of a voice that is speaking two hundred or two thousand miles away. Anything might happen after this. Anything is worth trying.

This is the true and necessary spirit of scientific research, the spirit of "try it and see what happens." If you graduate from radio and move on into a college, university or technical research laboratory somewhere you will find that the mental habits you formed in working out the details of your set will be exactly the mental habits most in demand in the larger field of general research.

Another aspect of amateur radio that is significant from the educational point of view is the fact that it seems to have succeeded in doing what it seems so difficult for schoolmasters to do. It has made education interesting.

The mathematical principles of inductance and capacity, of interference and tuning and the heterodyne, are not by any means easy to understand. If the average youngster were compelled to learn these principles in school he would



Keystone View Co.

TINKERING WITH "HOOK-UPS" MADE THIS RADIO AMATEUR WORLD-FAMOUS

Mr. John Reinartz is well known to American amateurs as the originator of the famous Reinartz circuit and of many other radio devices. It was a transmitting circuit devised by him that was used by Captain Deloy in the recent transatlantic transmission on a one-hundred-meter wave. Like many others, Mr. Reinartz owes most of his scientific training to his long interest in American amateur radio.

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Keystone View Co.

THE BOY WHO READ DIME NOVELS A FEW YEARS AGO IS NOW "BUILDING HIS OWN"

A young man who designs and builds his radio set is acquiring, says Dr. Whitney, a working knowledge of science as well as a training in those mental habits which are especially needed in scientific work.

consider, no doubt, that he was being grievously oppressed. Yet when these same principles concern his beloved radio set he tackles them not only without protest but actually with eagerness. And, what is more important, he succeeds in learning them.

Why is this true? Just why does the fact that something has to do with radio increase so largely the ease and interest with which young people learn it?

There are, I think, two reasons. They are the same reasons that explain the fact, so often lamented by the professors, that most students are more interested in athletics than they are in their studies. This fact does not seem to me an unnatural or even a deplorable one. It is a normal reaction to the fact that athletics possess to a high degree two characteristics that never fail to be appealing to the human mind; they involve the interest of a contest and they mean doing something by team-work.

These are the reasons why baseball and football have so strong a hold on the youthful mind and these same reasons apply with equal force to amateur radio. The element of contest in radio happens to be a contest against the forces of Nature, a mental golf bogey against static or fading or the physical imperfection of one's apparatus. But it is none the less a real and perceptible contest. The satisfaction of winning it, of overcoming the succession of obstacles that Nature puts in the way, for

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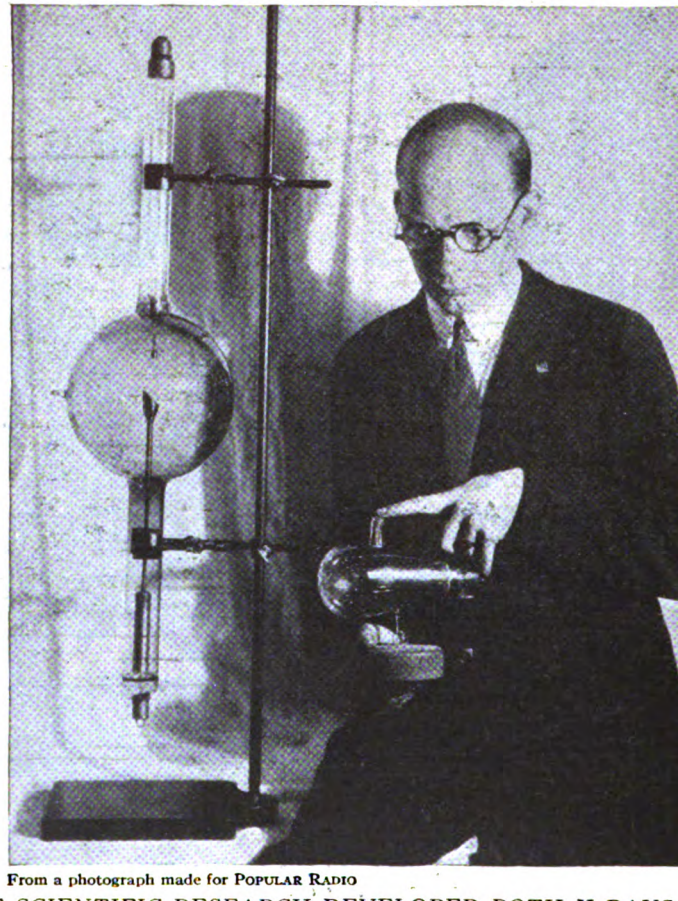

From a photograph made for POPULAR RADIO

THE SAME SCIENTIFIC RESEARCH DEVELOPED BOTH X RAYS AND RADIO

The small tube held by Mr. Killefer of the American Chemical Society is a model of the original X-ray tube devised by Professor Roentgen. Its modern brother is the large tube on the left. The research leading to the development of this modern tube (much of which was done under the direction of Dr. Whitney), has also led to the modern thoriated filament for vacuum tubes and to many features of the methods used in producing the vacua in hard tubes for radio use.

example, of hearing a program broadcast from the other side of the continent, is quite as thrilling as the joy of winning a football game or making a home run.

This satisfaction, by the way, is exactly the same as one gets out of successful scientific research of any kind. It is winning one's fight against the unknown that constitutes, I think all scientists will agree, the chief of the many satisfactions that scientific work affords.

The second attractive element of athletics, that of team-work, is also an element of radio. Radio is necessarily a co-operative business. It requires, at the least, a sender and a listener. It extends itself, very soon, to the group of kindred enthusiasts who form the local radio club. How vital an element this is in the radio world is sufficiently attested by the hundreds, probably thousands, of amateur radio organizations that are active all over the world.

All these things are matters of attitude, of habit of mind. They mean, I think, that the general mental outlook of the radio amateur is prepared, unconsciously, for scientific research. But

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we must not forget, also, the preparation which he acquires, also unconsciously, in the way of actual knowledge of facts.

The amateur starts out, let us suppose, with some simple kind of receiving set. He learns, by mere imitation, how to twiddle the dials or jiggle the catwhisker until the set gives him what he wants. Like all true scientists he is never quite satisfied and he keeps readjusting. For a time the why of it all doesn't interest him.

Then gradually this mental horizon widens. To our beginner electricity is merely a rather mysterious something that comes through wires into the house to light lamps and that will sting you if it gets out and bites you. A vacuum tube is merely a special kind of electric lamp with some little doo-dads inside it.

But one cannot play with radio very long and remain incurious. The why, for example, of the vacuum tube demands insistently to be answered. This opens up the wonderful and romantic story of the electron, and from that our fan goes on, step by step, into the mysteries of the atom and its structure and into the whole new world of modern physics.

This gradual training of the radio amateurs in scientific thinking and in the facts of science is going to prove, if I am right about it, a matter of very great importance to the scientific professions and to the country.

The world is more ready now for new undertakings than it has been before. It is learning by experience how it may advance through added knowledge of physical facts. While it is difficult to foresee improvements in our ways of living, it is not difficult to recognize them after the event, nor determine their laws.

We probably think of Champlain's first use of gunpowder against the American Indians as a natural outcome of the stinkpots of the ancients. We can look backward with boldness and certainty. We have myopia only on looking ahead.

It may be quite in accord with possibilities to consider the great army of American radio fans as the conquerors of future wars. With a people who are anxious to test the elasticity of human intellect, is it out of the question that our radio amateurs may yet teach foreign nations the American language? Even the English say they already hear and understand our broadcasting and amateur radio. The whole world can soon call and carry on a general conference about as quickly as a Kansas town could call a constable a few years ago.

Probably not one man in a thousand ever realized what the discovery and development of printing meant to the race. Most of us take it as a matter of course, but in the history of man it is a very recent event. It covers only the last two or three tenths of one percent of his existence. But see what a rapid development it gave the man. For the future the best guess we could make involves a still greater uplift because of radio, strange as it may sound, because we are already on a much superior plane for utilization and appreciation than the folk of five or six hundred years ago.

All other nations are watching our radio experiments. No other country has advanced half as far. Broadcasting is only starting abroad. Amateurs, the heart and backbone of our radio, are almost unknown abroad. The European laws will probably continue to discourage amateurs. Here everything will certainly be done to help them. What will we do with it? It is a great opportunity for every ingenious independent thinker or worker.

In *the house of the future we may cook our coffee, boil our eggs and summon our motor car by radio—and ride to the office on power transmitted by radio!* POPULAR RADIO *for April will describe some of the marvels that radio may bring into our homes.*

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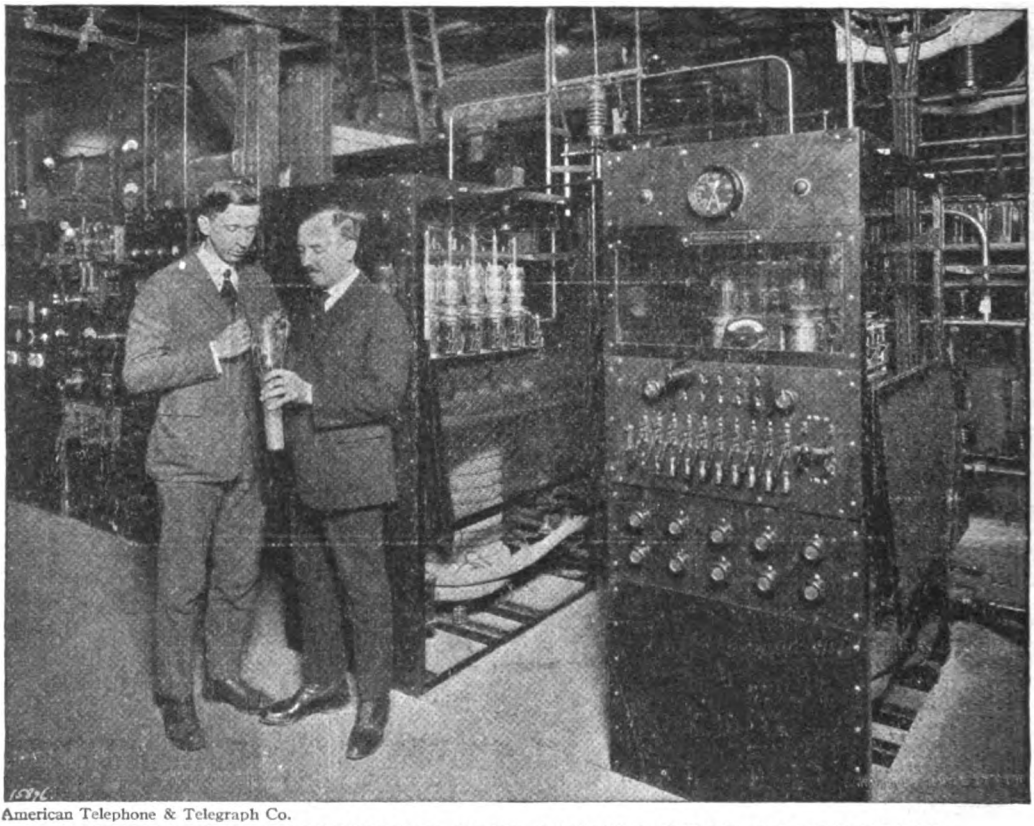

American Telephone & Telegraph Co.

WHERE THE RADIOPHONE TEST SIGNALS WERE TRANSMITTED IN NEW YORK—

Notice the great banks of tubes used in the transmitter that was employed in the daily transoceanic tests for determining field strength measurements for different periods of the day and night throughout the year.

Charting the Ether Lanes

FOR TRANSATLANTIC CONVERSATION BY RADIO

It is only a matter of time when we will talk across the ocean by radio as easily as we now talk short distances over wires. Scientists are preparing the way for this new link between the peoples of the world. The experiments carried on quietly during the last year show that the conditions of transmission between the two sides of the Atlantic vary from time to time with night and day, and from season to season, and that varying amounts of power are necessary to transmit clear speech across the ocean in accordance with these variations in transmitting conditions. This article tells of these tests.

By HARRY A. MOUNT

THE day is not far distant when the radio telephone will enable the President of the United States to exchange greetings by word of mouth with the King of England across 3,000 miles of water.

There is perhaps no single event which is looked forward to with keener interest on the part of radio enthusiasts and which will be considered more significant by the public at large than the establishment of transatlantic radio-

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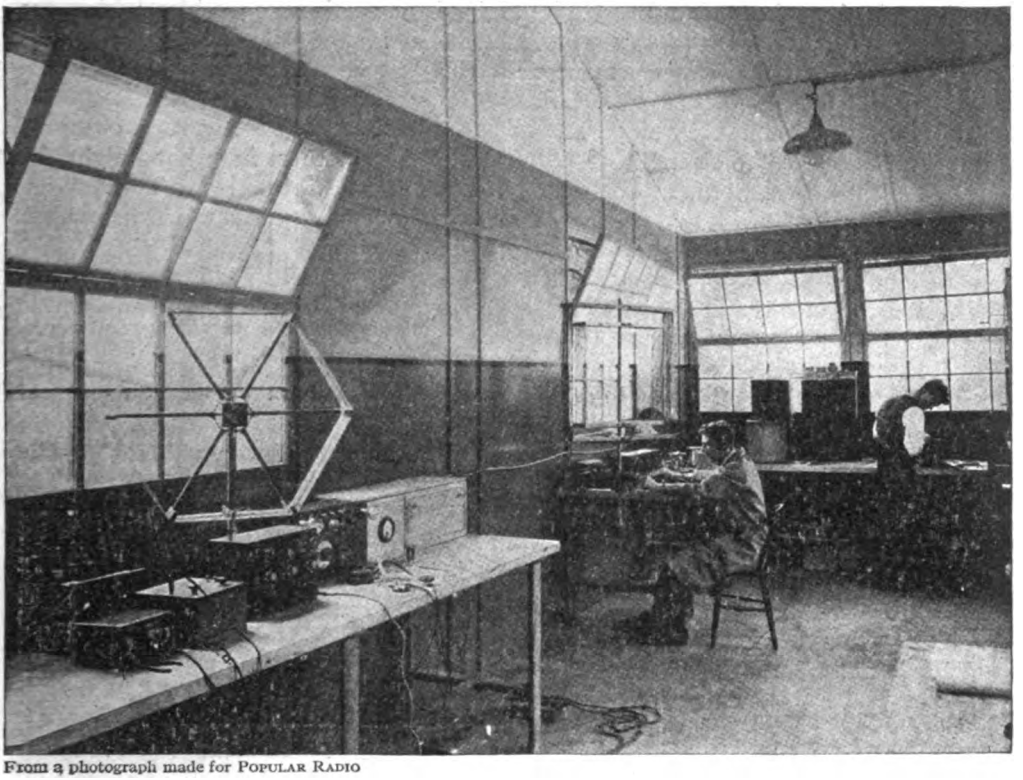

From a photograph made for POPULAR RADIO

—AND WHERE THEY WERE RECEIVED IN LONDON

Here is the laboratory in which the receiving data was compiled and tabulated. The data here compiled is summarized in the graphs which are reproduced in Figures 1 to 5, that accompany this article.

telephone service. When this event comes it will, of course, enable anyone who desires to talk to Europe to do so, just as anyone can now use a local or long-distance telephone. Indications are that such a service is not far in the future.

Some months ago a successful demonstration of transatlantic telephony was given which involved the continuous transmission of messages from New York to London for a period of over two hours. It was a one-way circuit, however, and the recipients in London had to reply by cable. Many steps remain to be taken between this one-way demonstration and two-way service which is continuously available during the twenty-four hours of the day.

One of the most essential steps leading to a complete two-way system is an extensive knowledge of the transmission characteristics of the ether from hour to hour, day to day and season to season. This knowledge is as necessary in the laying out of a successful radio-telephone system as a knowledge of the topography of the proposed route of a railroad would be to the laying out of the road-bed. The engineers in charge of locating the track must know the exact whereabouts of hills and valleys, streams and marshes, and similarly, the radio engineers in designing a vast transatlantic telephone system must know, in as minute detail as possible, all of the characteristics of the ether and the variations to which it is subjected because of the influence of the earth's atmosphere.

Several months have now been spent in gathering facts concerning transmis-

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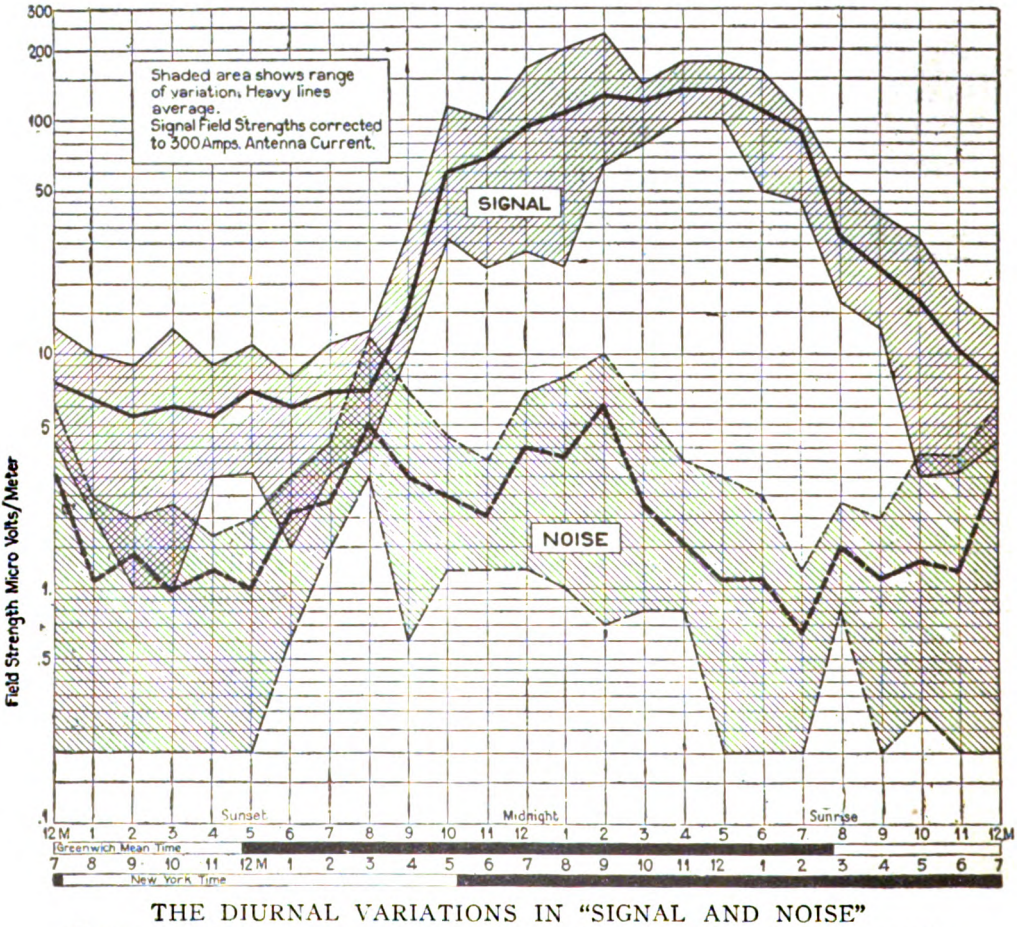
sion through the ether of transatlantic radio-telephone messages. In this work the equipment which was successfully used in talking across the Atlantic last winter was supplemented by apparatus designed to measure the strength of the signals, and the interference and noise received in London.

The following data is summarized from an engineering paper prepared by H. D. Arnold and Lloyd Espenschied, and recently presented before the Institute of Electrical Engineers.

With the test set installed in London data was collected on the strength of signals sent out from Rocky Point, Long Island. The three quantities which are included in the transmission measurements, namely the signal strength, the noise strength and the percentage of words received correctly, are observed one after another in what might be termed a unit test-period. The following program is representative of such a period:

Five minutes of tone-telegraph identification signals for receiving-adjustment purposes.
Ten minutes of disconnected spoken words.
Ten minutes of a succession of five-second, tone dashes separated by five-second intervals for measurement of the received field strength.

Immediately following this test, the


Shaded area shows range of variation, Heavy lines average.
Signal Field Strengths corrected to 300 Amps. Antenna Current.
SIGNAL
NOISE
Field Strength Micro Volts/Meter
300
200
100
50
10
5
1.
.5
.1
Sunset
Midnight
Sunrise
12M 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12M
Greenwich Mean Time
7 8 9 10 11 12M 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7
New York Time

THE DIURNAL VARIATIONS IN "SIGNAL AND NOISE"

FIGURE 1: *This graph shows the variation of received signals and noise during each day at various times, beginning on January 1st and ending February 23rd. The top portion of each shaded section indicates the highest values obtained; the lower portion shows the lowest values. The heavy center lines give the average values.*

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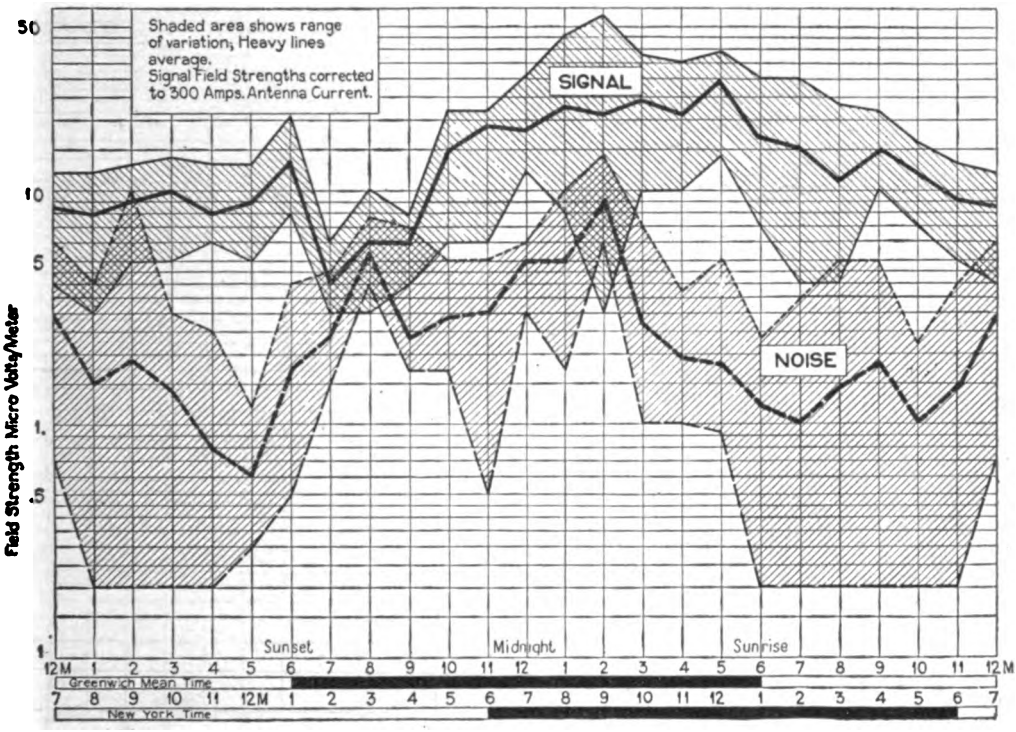
Shaded area shows range of variation, Heavy lines average.
Signal Field Strengths corrected to 300 Amps. Antenna Current.
SIGNAL
NOISE
Field Strength Micro Volts/Meter
50
10
5
1.
.5
1
Sunset
Midnight
Sunrise
12M 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12M
Greenwich Mean Time
7 8 9 10 11 12M 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7
New York Time

A CHECK-UP ON FIGURE 1

FIGURE 2: *This curve gives the same sort of data on the field-strength measurements as Figure 1, except that the measurements were made between February 25th and April 9th.*

London observers measured the noise level.

This unit test-period was repeated every hour over a period which varied from several hours to as long as two days and usually ran for about twenty-eight hours. The measurements which started on January 1, 1923 are still in progress.

The data obtained during these months of testing is summarized in the curves given in this article.

Figure 1 shows the variation of received signals and noise for the winter period between January 1st and February 23rd. The range of signal strength is indicated by the cross-hatched area. The upper boundary of this area gives the strongest signals received during the period under consideration; the lower boundary gives the weakest signal, and the heavy intermediate curve gives the average of all the observations. The time of day at which the observations were made is given along the horizontal axis in both Greenwich time and New York time, and the black strips indicate the hours of night at London and at New York. The overlapping of these strips corresponds to darkness extending across the Atlantic and including both New York and London. It is evident that this condition accompanies the maximum intensity of signals.

The time scales for New York and London bring out another important fact; assuming that the business day at New York begins at 9 A.M., we see that it overlaps the business day at London by only three hours. During these three hours the strength of received signals is practically at its lowest value.

Figure 2 is drawn on the same basis

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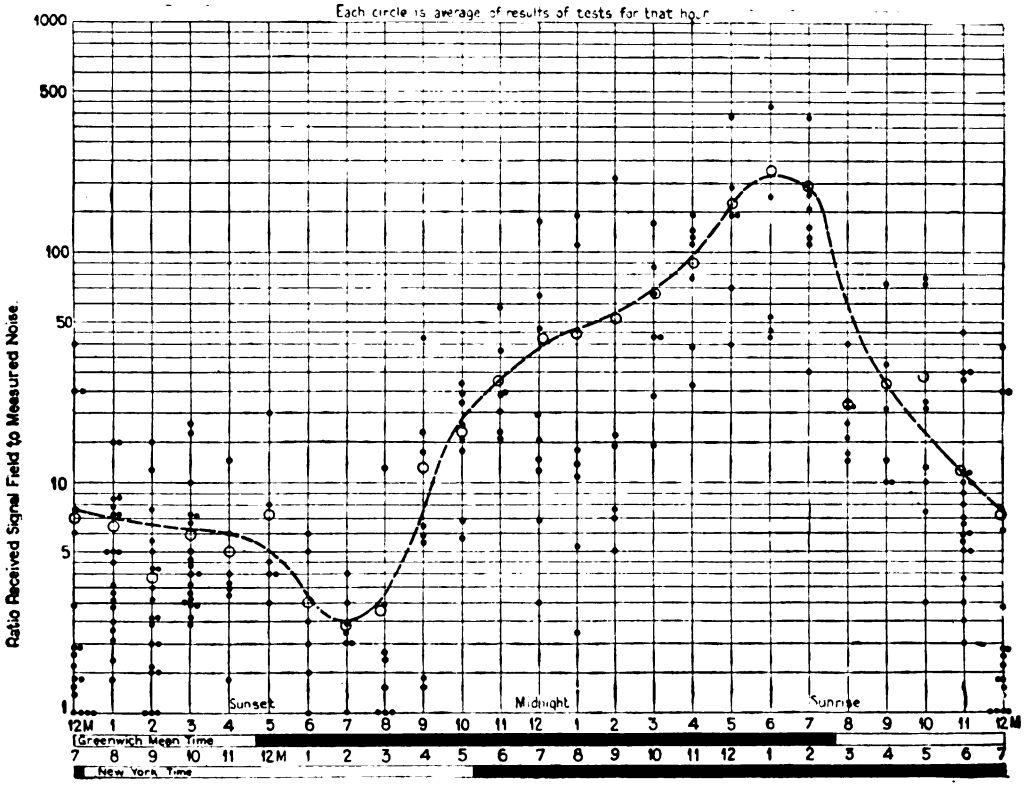
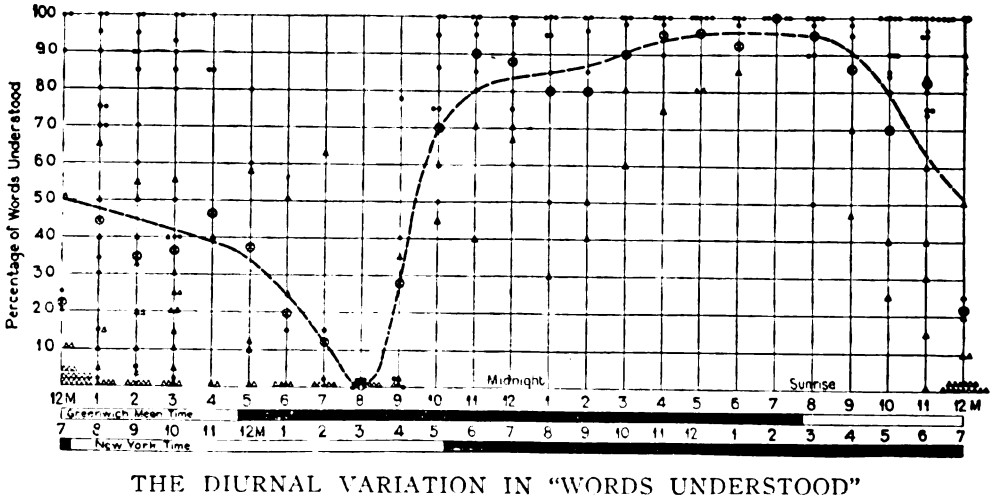

Each circle is average of results for that hour
Ratio Received Signal Field to Measured Noise
1000
500
100
50
10
5
1
Sunset
Midnight
Sunrise
12M 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12M
Greenwich Mean Time
7 8 9 10 11 12M 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7
New York Time

THE DIURNAL VARIATIONS OF "SIGNAL TO NOISE" RATIO

FIGURE 3: *The curve in this diagram shows the diurnal variation of the ratio of received signals to noise during the same period as occupied for the measurements in Figure 1; this graph was made from the same data.*



THE DIURNAL VARIATION IN "WORDS UNDERSTOOD"

FIGURE 4: *This curve shows the variation, throughout the hours of the day and night, of the percentage of words accurately received. Notice that the best period lies throughout the late dark hours of the morning, with a minimum towards the afternoon and evening.*

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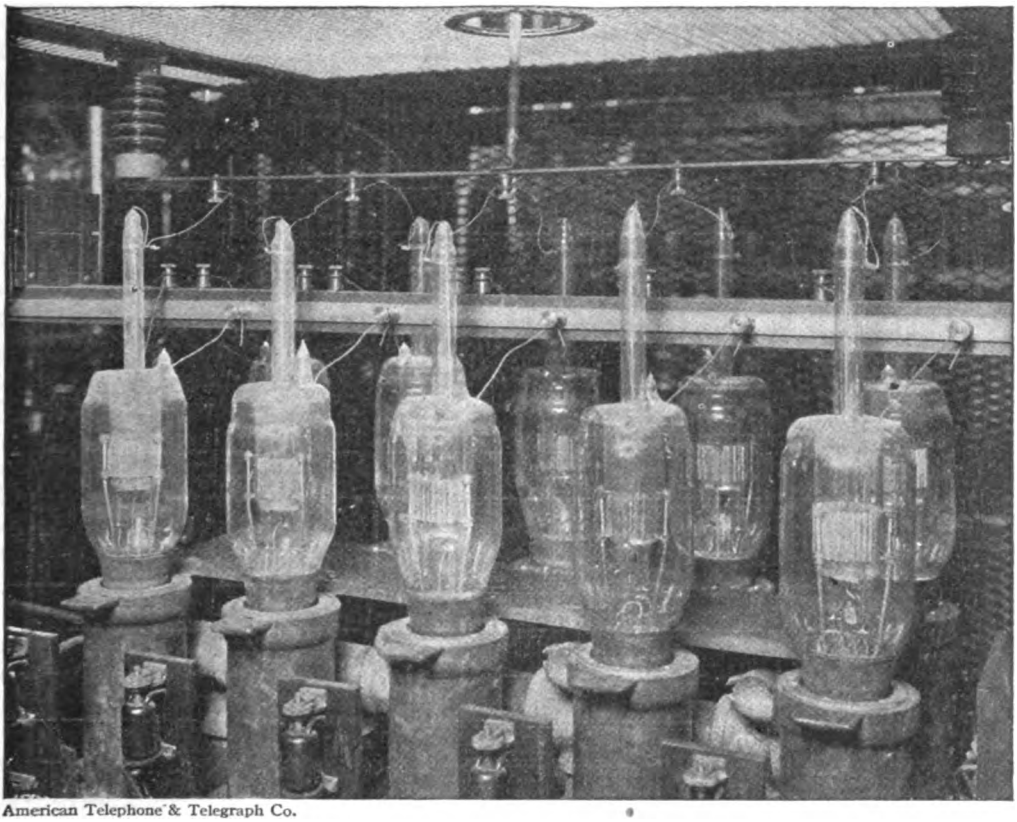
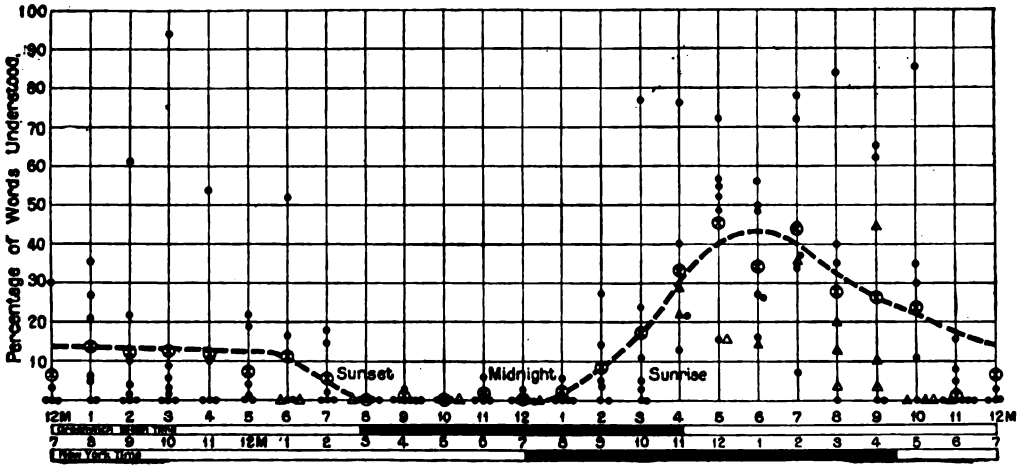


American Telephone & Telegraph Co.

THE HUGE VACUUM TUBES THAT FURNISH THE POWER

This is a close-up view of a bank of ten powerful water-cooled vacuum tubes. The whole bank is rated at a power of 200 kilowatts.



ANOTHER VARIATION OF "WORDS UNDERSTOOD"

FIGURE 5: *This curve shows the same variation as Figure 4 except that the data was collected between April 15th and June 11th. Each circle is average of all tests for that hour, including triangular points. The latter are known to be cases in which the low percentage is due to unnatural causes.*

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as Figure 1 but represents observations made between February 25th and April 9th. Two differences show up at once between this curve for the spring months and the curve for the winter months. First, the strength of received signals is (on the average) less in the spring, and second, the large variation between day and night has disappeared.

On the lower part of each diagram the values of the strength of interference (or noise) are plotted.

The term "noise" may need a word of explanation. It includes both interference from static and interference from other stations. Much of the noise before 6 P.M. London time is due to interference from neighboring stations but that which is shown between 6 P.M. and 4 A.M. London time consists mainly of static.

The cross-hatched area of the noise curve gives the range of variation, the upper boundary representing the maximum and the lower boundary the minimum while the heavy median line gives the average of all observations.

Both Figures 1 and 2 indicate that the maximum noise is reached at about 2 A.M. London time. Up to this time the night period extends over London and a sector on the earth considerably to the east and including Europe, Africa and Asia. The noise begins to drop off shortly thereafter and reaches its minimum at sunrise at London. This could be accounted for on the assumption that the major source of the noise lies considerably to the east of London and that transmission of stray electric waves to London is gradually diminished in efficiency as daylight overtakes the path of transmission. It will be noticed that the average noise level is noticeably higher during the spring months than during the winter.

In Figure 3 are plotted the diurnal variation of the ratio of signal strength to noise strength over the same period as is covered by Figure 1. This ratio is, indirectly, a measure of the understandability of received speech and is derived from the observations used in plotting the curves of Figure 1.

Figure 4 shows, directly, the variation through the twenty-four hours of the percentage of words which were accurately received. Each point corresponds to the percentage of words accurately received during one unit test-period. In many of these tests the interference was caused by radio-telegraph stations and in these cases the data is indicated by triangular dots. The dashed curve is a smoothed curve for the points plotted. It indicates that reception is best during the late night and early morning, that it drops off during the day, reaching a minimum during the evening.

As might be expected, the night reception is shown to be considerably better during the winter months than during the summer. This is seen by comparing Figures 4 and 5—the latter giving data collected between April 15th and June 11th. Remember that the period during which the business days on the two sides of the water overlap, are the three hours between 9 A.M. New York time and 5 P.M. London time. Figure 5 shows the need of extra-powerful sets to maintain commercial service at this period of the day, when the demand for service will be particularly heavy. In this connection it may be pointed out that observations indicate that a more favorable showing could be made by the use of longer wavelengths, and it may be possible to take advantage of this fact in establishing a real commercial service.

Will Radio Run Our Street Cars?

THIS *query is not as fantastic as it at first appears to be; the possible transmission of power by radio has long occupied the serious attention of scientists. What has been done and what may be done in this field of research will be told in* POPULAR RADIO *by Dr. E. E. Free.*

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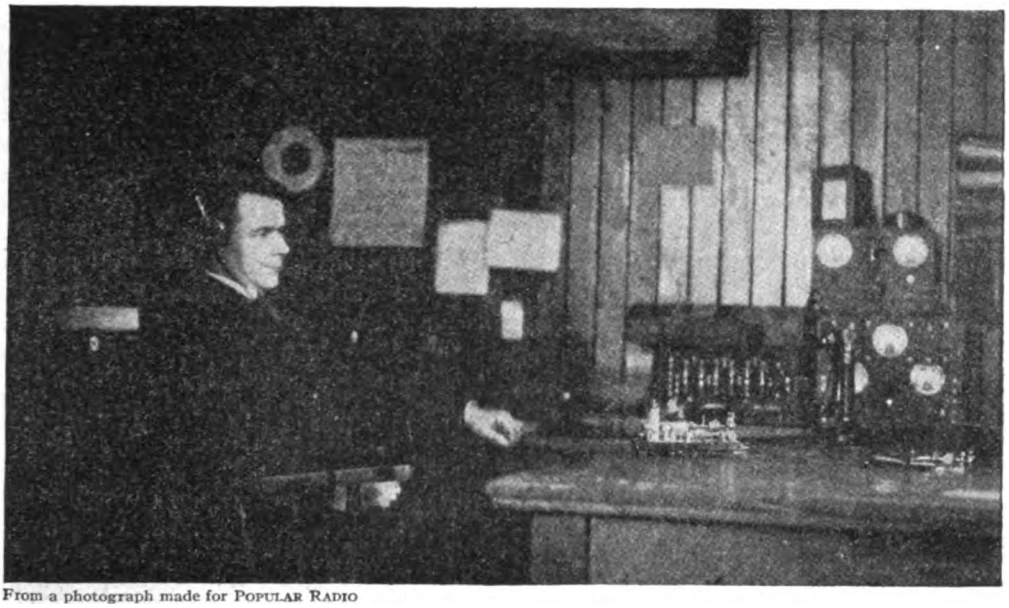

From a photograph made for POPULAR RADIO

The author of this article, who has long been an advocate of the essentially practical broadcasting alphabet described below, at his radio station in Prince Rupert, B. C., Canada

"This Is Station William-Have-Nan"

Did you ever listen to a distant broadcasting station signing off—only to be left uncertain whether the announcer said "WCAD," "WZAB" or "WDAP"? Here is described a unique word-letter alphabet system that would eliminate this doubt; it has been tried and adopted in both the American and British naval circles where it has been fully worked out and has proven its worth.

By W. T. BURFORD

IF we live within easy range of a broadcasting station we know well enough, when we have set the knobs of our receiver at their proper adjustment, whether the sounds we hear are or are not the signals of that particular station. Indeed, if we confine our efforts to the reception of broadcast programs from any near-by and familiar station, the problem of identifying the transmitting point will seldom present itself.

But if we switch on our amplifiers and tune for more distant signals, occasions will arise when the call-letters of the transmitting station may be a matter of uncertainty. For the broadcast announcer, no part of the program requires more care in the delivery (particularly as to enunciation) than the three or four letters of the alphabet which identify his station. His well-rounded accents may be trained to pronounce unerringly the title of a foreign operatic aria, but no combination of efficient equipment and faultless diction can be depended on to carry through space those few letters that mean so much.

Was that an A or a K—or an H? Was that a P or a B? Was it a G or a V?

We know that, separated from the

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speaker by only a few yards, or in the same room, we might have difficulty in recognizing these letters; we can hardly hope, then, that when the slight margin of mechanical error which must accompany the very best microphone is added to the human element, to hear better by radiophone than by direct audition.

The difficulty does not exist in the case of all letters; if the call-sign happens to consist of such letters as W, Y, F, X (or a few other distinctive letters) there would be little chance of confusion. But in the pronunciation of a few of the letters of our alphabet the consonantal sound has to have an *-ee* or an *-ay* sound attached to it to make it readily audible. In addition to this, another difficulty consists in the similarity of certain consonantal sounds.

As stenographers well know, there are certain letters that may be regarded as pairs. They might be called "parallel sounds," and in some systems of shorthand writing this similarity is embodied in the characters which represent the consonants by the employment of thick and thin strokes respectively for the thick and thin sounds (technically, the continuants and explodents) which form the pairs of parallels. Thus T is the thin brother letter of D, as P is of B; therefore, to enunciate a T so that it will not sound like a D, or a P so that it will not sound like a B, our broadcast announcer has to overcome, not only the difficulty of the similar *-ee* ending, but also that of the basic similarity of the consonants.

It is not only in radio broadcasting that this trouble has arisen. Long ago the problem confronted telephone users and they overcame it by the familiar but roundabout method of saying "G for George," "A for Algernon," "M for Mary," and so on. Though cumbersome, it was an easy solution, for it possessed the advantage of being self-explanatory and needing no prearrangement. A somewhat similar but more systematic way has from time to time been devised by large organizations, such as military forces.

The United States Navy, for instance, has developed a special list of spelled out names for the letters, both for telephone work and for visual signaling, thus enabling those who are familiar with the list to recognize quickly the identifying word, and thereby its initial letter.

The U. S. Navy official alphabet is as follows:

A	Affirm
B	Baker
C	Cast
D	Dog
E	Easy
F	Fox
G	George
H	Have
I	Inter (rogatory)*
J	Jig
K	King
L	Love
M	Mike
N	Nan
O	Option
P	Prep (aratory)*
Q	Quack
R	Roger
S	Sail
T	Tare
U	Unit
V	Vice
W	William
X	X-ray
Y	Yoke
Z	Zed

The system is easily and quickly learned, and its use eliminates the possibility of errors.

There is no need for the speaker to hesitate in choosing the word; he has already got it firmly fixed in his memory, and is sure that the listener will recognize the sound. The words used have been selected with the utmost care to eliminate confusion between either their vowel or their consonantal sounds.

The British military signal service years ago also developed a nomenclature for the alphabet which removes practically all chances of error in reading the letters as they are spoken. By giving certain letters syllabic form—giving them bulk, one might say—the depend-

*This part of the word is eliminated in actual practice.

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Form 772 a.

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
RADIO SERVICE

INTERNATIONAL RADIOTELEGRAPHIC CONVENTION

LIST OF ABBREVIATIONS TO BE USED IN RADIO COMMUNICATION

ABBREVIATION	QUESTION	ANSWER OR NOTICE
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?	This is .....
QRB	What is your distance?	My distance is .....
QRC	What is your true bearing?	My true bearing is .....degrees.
QRD	Where are you bound for?	I am bound for .....
QRF	Where are you bound from?	I am bound from .....
QRG	What line do you belong to?	I belong to the .....Line.
QRH	What is your wavelength in meters?	My wavelength is .....meters.
QRJ	How many words have you to send?	I have.....words to send.
QRK	How do you receive me?	I am receiving well.
QRL	Are you receiving badly? Shall I send 20? . . . — . . . for adjustment?	I am receiving badly. Please send 20. . . . — . . . for adjustment.
QRM	Are you being interfered with?	I am being interfered with.
QRN	Are the atmospherics strong?	Atmospherics are very strong.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRQ	Shall I send faster?	Send faster.
QRS	Shall I send slower?	Send slower.
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready. All right now.
QRW	Are you busy?	I am busy (or: I am busy with .....). Please do not interfere.
QRX	Shall I stand by?	Stand by. I will call you when required.
QRY	When will be my turn?	Your turn will be No.....
QRZ	Are my signals weak?	Your signals are weak.
QSA	Are my signals strong?	Your signals are strong.
QSB	Is my tone bad? / Is my spark bad?	The tone is bad. / The spark is bad.
QSC	Is my spacing bad?	Your spacing is bad.
QSD	What is your time?	My time is .....
QSF	Is transmission to be in alternate order or in series?	Transmission will be in alternate order.
QSG	.....	Transmission will be in series of 5 messages.
QSH	.....	Transmission will be in series of 10 messages.
QSJ	What rate shall I collect for?	Collect .....
QSK	Is the last radiogram canceled	The last radiogram is canceled.
QSL	Did you get my receipt?	Please acknowledge.
QSM	What is your true course?	My true course is .....degrees.
QSN	Are you in communication with land?	I am not in communication with land.
QSO	Are you in communication with any ship or station (or: with .....)?	I am in communication with ..... (through .....).
QSP	Shall I inform.....that you are calling him?	Inform.....that I am calling him.
QSQ	Is .....calling me?	You are being call by.....
QSR	Will you forward the radiogram?	I will forward the radiogram.
QST	Have you received the general call?	General call to all stations.
QSU	Please call me when you have finished (or: at .....o'clock)?	Will call when I have finished.
*QSV	Is public correspondence being handled?	Public correspondence is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?	Increase your spark frequency.
QSX	Shall I decrease my spark frequency?	Decrease your spark frequency.
QSY	Shall I send on a wavelength of..... meters?	Let us change to the wavelength of..... meters.
QSZ	.....	Send each word twice. I have difficulty in receiving you.
QTA	.....	Repeat the last radiogram.
QTE	What is my true bearing?	Your true bearing is.....degrees from....
QTF	What is my position?	Your position is...latitude...longitude.

*Public correspondence is any radio work, official or private, handled on commercial wavelengths.

When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation.

THE NUCLEUS OF A UNIVERSAL LANGUAGE

These abbreviations are observed internationally; they constitute what is, in effect, the beginning of a world tongue. Every amateur who applies for a license to transmit must pass an examination on this list.

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ance upon hearing the letter itself is lessened, as the letter is recognized by its close association with others.

The British official alphabet is as follows:

A	Ack
B	Beer
C	C
D	Don
E	E
F	F
G	G
H	H
I	I
J	J
K	K
L	L
M	Emma
N	N
O	O
P	Pip
Q	Q
R	R
S	Essus
T	Toc
U	U
V	Vic
W	W
X	X
Y	Y
Z	Zed

It will be seen that the few alterations that are made in the names of the letters are such as can be committed to memory in a short time by any one, and practical experience in the field for which they were designed has shown that they are effective. Applying this signal alphabet in the case of call letters KDTP, all that it is necessary to say is "K—Don—Toc—Pip." Clearness is assured at no sacrifice of brevity. KABP is simply "K—Ack—Beer—Pip;" WMSV is "W—Emma—Essus—Vic;" KICD is "K—I—C—Don." But KCEF, WGY, and many other combinations are not modified in any way, yet they are equally safe, by contrast with the letters in which we know a change is made. It is not necessary, for example, to make any change in the letter N, when we use Emma in place of M.

In the event of one of these alphabets being adopted for broadcasting, there would be some degree of danger of arbitrary change being introduced before the altered letters gained general acceptance. Possibly some of those interested, prompted by a desire to improve, but giving insufficient thought to the matter, would suggest the change of certain letters. It must therefore be pointed out that both of the suggested alphabets have already gained something like international currency, and both of them stood the gruelling test of use in the field during the great war.

The value of such an "unmistakable" alphabet would of course not be confined to radio broadcasting alone. It could be applied with equal advantage for radio-telephone purposes generally, in calling between stations and for "spelling out" such words as happened to present difficulty at the receiving end. And its use in radio would soon popularize it sufficiently to make it a boon to the ordinary telephone using public.

But, when all is said, one can have no idea of the advantages in the use of a radio alphabet until one *tries it*.

Try it when the speaker has a cold!

Will Radio Bring About a World Language?

MANY *of the best minds both here and abroad believe that it will—or at least, that it will be an important factor in developing a form of communication that can be understood by the many peoples of the world and that will assist in material ways in bringing about a better era of understanding between the nations. What is being done to encourage this significant development will be told in* POPULAR RADIO *by Mr. Henry D. Hubbard of the International Research Council and by Dr. Edwin E. Slosson.*

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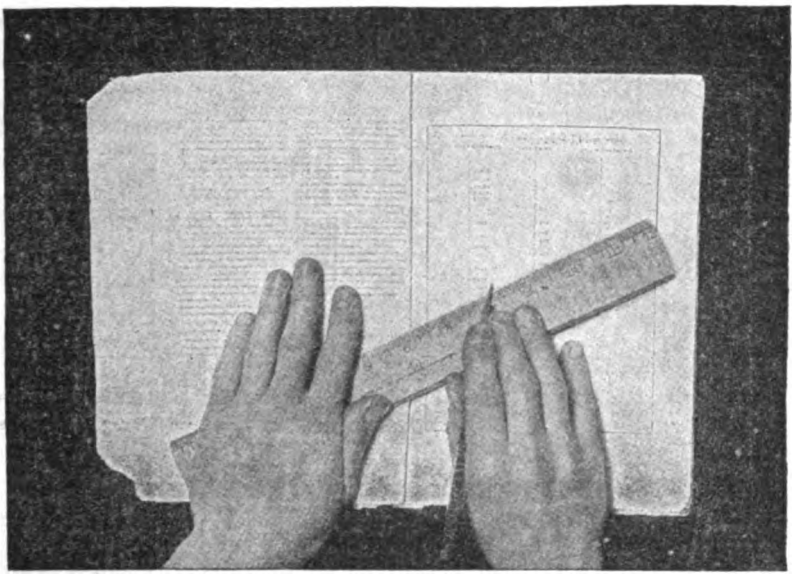

ALL YOU NEED IS A RULER, A PENCIL AND A PAIR OF HANDS

By means of the table on the opposite page the amateur who builds his own apparatus may calculate in an instant the design for a condenser that will have a pre-determined capacity, or find out the capacity of a condenser that is already built.

A MEASUREMENT CHART

FOR USE IN DESIGNING A TRANSFORMER

ARTICLE NO. 6

The previous articles contain charts *For Determining the Constants of Radio Circuits and Calculating Capacities of Condensers in Series,* in February, 1923; *For Determining the Dimensions of Your Coil,* in March, 1923; *For Determining the Capacity of a Condenser,* in May, 1923; *For Determining the Capacity of Your Antenna,* in July, 1923, and *For Determining the Constants of a Loop Antenna* in August, 1923.

By RAOUL J. HOFFMAN, A.M.E.

ALTERNATING current may be transformed from one voltage to another by the use of a transformer that consists of a primary and secondary winding wound on an iron core.

The transformers are used to "step up" or to "step down" the voltage of the current.

The "step up" transformer may be used for the CW (continuous wave) transmitting stations; the "step down" transformer may be used for supplying low-voltage current for charging storage batteries. Some form of rectifier must be used in the latter case.

The fundamental formula for the transformer is

$$E=4.44\ f\ F_m\ n100{,}000{,}000.$$

Where E =the effective value of the impressed voltage.
f =the frequency.
F_m=the maximum value of the magnetic flux.
and n =the number of the primary turns.

The magnetic flux is

$$F_m=A.\ df \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

where A =the area of the cross-section (½ square inch for ½ KW, 1 square inch for 1 KW).
df_a=suitable flux density per square inch to be assumed as 60,000.

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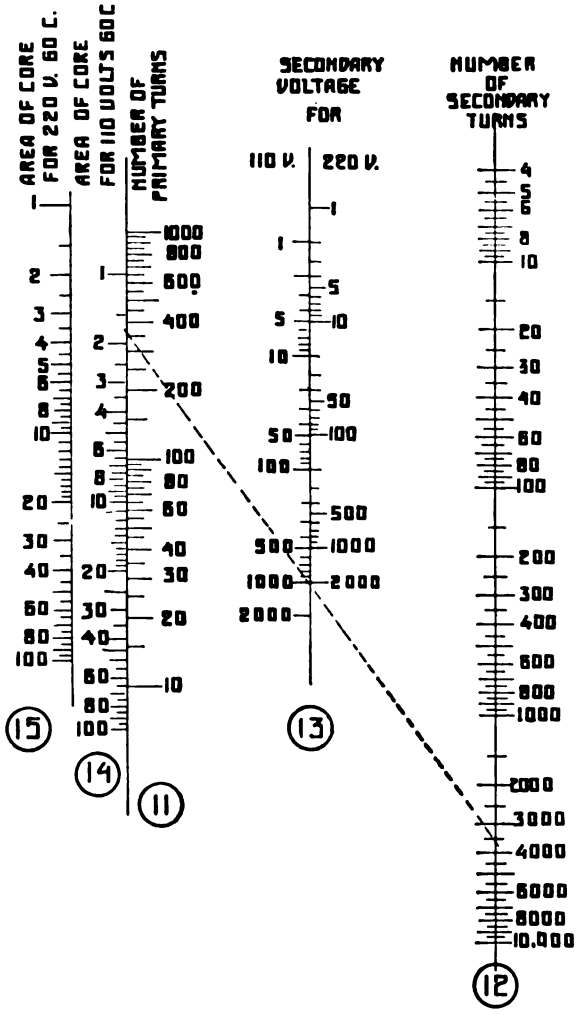
THE TRANSFORMER CHART

This mathematical chart enables you to calculate the proper design for your transformers for alternating-current work. How to use the chart is fully described in the text.



From equation (1) and (2) and assuming a frequency of 60, we will have the number of primary turns:

P_n=6.3 Volts/Core Area.....3

The efficiency in a well designed transformer is very high, but for simplicity we will assume a 50 percent efficiency, so that a rheostat can be connected in series with the primary.

The ratio of the secondary voltage and the primary voltage is equal to the ratio of the number of the secondary turns and the primary turns.

In order to simplify the above mathematical operations and the evaluations of the equations, a chart has been substituted and is here illustrated with the aid of an example:

The example is to design a transformer having a 1,000-watt input from a lighting current of 110 volts, 60 cycles, an output of 1,000 volts, at 50 percent efficiency. The area of the core is assumed to be 2 square inches. The current to be calculated for the primary will be then 2,000 watts.

Connect 2,000 on scale No. 1 with 110 on scale No. 3 and read at the intersection with scale No. 2 the resulting 18 amperes; then connect 18 on scale No. 4 with 110 on scale No. 3. You will find the line intersecting scale No. 5 at 5.5 ohms which will be the maximum resistance in the primary circuit.

Looking at scale No. 14 we find the cross-section of 2 square inches connected with 350 on scale 11, which is the number of the primary turns.

Connect 5.5. on scale No. 6 with 2 on scale No. 7, then connect the intersecting point on the reference line No. 8 with 350 on scale No. 9. We find the line intersecting scale No. 10 at 20 which is the minimum thickness of the wire in B & S gauge to prevent overheating. We can take No. 14 to 16 wire.

The secondary unit will give us 1,000 watts with a voltage of 1,000. Connect 350 on scale No. 14 with 1,000 on scale No. 13; the line will intersect the scale No. 12 at 3,700 which is the number of the secondary turns. Connect 1,000 on scale No. 1 with 1,000 on scale No. 3; the line will intersect scale No. 2 on 1; then connect 1 on scale No. 4 with 1,000 on scale No. 3. We find the line inter-

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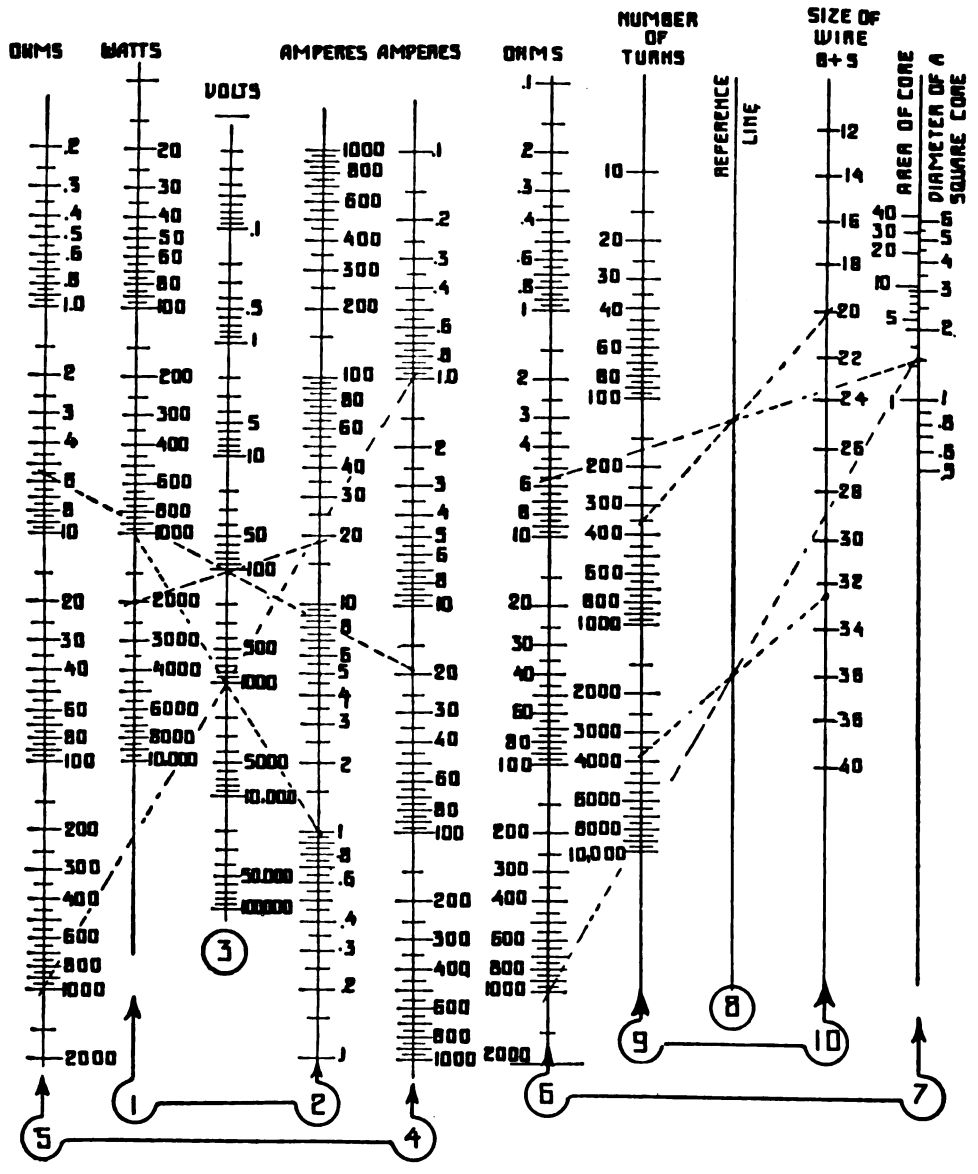

secting the scale No. 5 at 1,000 which is the resistance permissible in the secondary circuit.

Connecting 2 on scale No. 7 with 1,000 on scale No. 6, the line will intersect the reference line No. 8; this intersecting point connected with 3,700 on scale No. 9 gives us the required wire, No. 33 B & S gauge on scale No. 10. For efficiency a wire of No. 34 to 36 could safely be employed.

For 220 volts read values on scale No. 15, but take point of calculation across to scale No. 14.

The next MEASUREMENT CHART—*No. 7 of this series—will enable you to determine the maximum capacity of your variable condensers.*

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From a photograph made for POPULAR RADIO

I Carry My Battle to the Roof

For vicious cussedness, give me three snaky, temperamental coils of hardened copper wire. "Damn you," said I, "I'll stretch you flat and pin you down!" And I did.

My FOOL-PROOF SET

A first-hand account of what really happened when a real novice put up his first radio receiver

By GELETT BURGESS, B.Sc.

YES, I am a Bachelor of Science. With shame I admit it. I was graduated from one of the most polysyllabic scientific schools in the United States. Why, then, was I chosen by the editor of this magazine as the typical ignoramus to tell of my blundering attempts to install a radio set? Listen, my children, and you shall hear, of how he tried, this volunteer.

I know nothing, absolutely nothing, about electricity. Moreover, I don't want to know anything about it. I hate electricity.

It came about this way. At seventeen all I knew of the unpleasant subject was that electricity, somehow, rang bells. Oh, yes, I was also aware, through childish experiments, that if you hitched a piece of copper to a piece of zinc with a wire, and dipped them into a tumbler of blue vitriol solution (get that, so far?), you could copper-plate a dime so that it might be passed off by the dishonest as a cent. A slow and impractical way of making money, that seemed to me.

However, at the Massachusetts Institute of Technology—my Junior year, it was—I was rather excited. The great mystery, electricity, was to be revealed. How I looked forward to batteries, dynamos, telephones, arc lights! Wouldn't everything now be made plain to my wondering mind? Came the fatal day

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when Professor Cross mounted the platform. Out came my notebook. But, alas for my stillborn hopes! Never once did that erudite professor condescend to touch the earth. Why, for six long, soul-sickening months, in those terrible lectures, he got no nearer bells and batteries than elephantine formulas like this:

$$V = 2\int_{o}^{l/2} \frac{2\pi r\sigma}{\sqrt{(r^2+x^2}}\, dx$$

Isn't it horrible?

Years and tears it was before I could look at a copper wire without blenching and turning pale. . . . And then came the automobile.

Now, you can be a baseball fan without even knowing how to hurl a spit ball. A movie fan, too, you may be without ever having heaved your chest in front of a camera. But to be an automobile fan—in those pristine days when owners were still to be seen lying greasy, sweaty and profane on their backs under recalcitrant cars—you really had to know something about machinery—yea, even a little about that dread Nemesis, electricity. To my horror, I found on my first machine, wires, batteries, sparks! And so, like a medical student dissecting his first cadaver, mastering my disgust, I had to handle those fearsome copper wires, handle them till, in the fullness of time, I got, somehow, so that I could make them do my will. I had to, or the darned thing wouldn't work.

And so it was with this craze of millions, this world fad, radio. That's the worst of a receiving set. You simply can't own one without, in spite of yourself, learning a few simple things about electricity. Insidiously, like kissing widows, it gets you in its clutches. And the first thing I knew, I was turning up those innocent little lamps, twirling apparently harmless black knobs, and grinning like a wise owl as I handed the telephone headpiece to an admiring friend, saying, "Want to hear a fox trot from Camden?" just as if I were Steinmetz himself.

But those mysterious black boxes! How they work, I give you my word I haven't the faintest idea. I hope I never shall have. To be sure, I have burglarized them and peered into their entrails. As a self-respecting boob I had to do that. But I was well paid for my inquisitiveness. What I expected to see, naturally, was something like the diagram my technical friend gave me in explanation.

But what did I find? Reader, believe me, it wasn't a bit like that. If wasn't the third cousin to it. Where were those fascinating coiled snakes? Where those arrows shooting Northeast? A few bird-cages and mousetraps I found, and worm-like wires only. Hastily I screwed down the coffin lid.

* * * * * * * *

The first section that arrived of my radio set was fairly simple. A modest $45 worth of fun and amusement. When they were disemboweled, those three big cartons, I found—let's see—a vacuum tube receiver, two "B" batteries, telephones, insulators and many, many miles of copper wire. But to me the apparatus was as terrifying as an infernal machine. In fact, our maid, being half Patagonian, thought it was an infernal machine—knew it was—and fled the room. But I was brave; I stayed on right at the switch. Others had handled them and lived. So, please God, would I.

Now you have read, doubtless, of that boy prodigy who contrived a radio set so small that it could be packed into a match box. That monstrous boy, I verily believe, has been the author of more inferiority complexes than even Sigmund Freud. Poor me, at least, he at first sight reduced to a consciousness of electrical ignorance

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comparable only to that of an earthworm. Glowworms, naturally, know far more than I. So base, indeed, he made me feel, that had I ever erected (as I have in humble moments planned) a statue to that most precocious genius, I knew that, inevitably, some dark night I would steal forth and with my own inept hands revengefully smash the memorial of that super-kid.

But there were other boys, I was to find, many other boys, almost as terrible. In fact it seems to be only boys of fourteen who really understand inside radio. Adults fool with it; they guess and experiment. Professors and engineers conceal their stupidity behind mathematical equations. But boys read those columns of *Answers to Radio Questions* in the newspapers as if they were dime novels or baseball reports. To me those inscriptions are almost pure cuneiform.

Half-way, I confess I got into Mr. Cockaday's wonderful book. But, like the lurid memory of a rough channel passage when I was young, it only brought back my sophomoric nausea. I not only hated electricity with all the whilom bitterness, but I now fairly despised it. I'd hate to tell you what I really think of an electron, positive or negative. A creature that will submit to be forced to run along a wire, jump spark-gaps, crawl through white-hot filaments and be condensed and amplified and inducted and everything at the behest of a fourteen year old boy I consider unworthy of my respect And when it does escape, to wave through miles of free air, it's caught like a half-witted mouse by the first boy with a variocoupler he has made himself.

Still, here was my outfit, right in the house, and I was pledged to investigate its tricks and its manners. Moron I might be, but I had to install the thing all alone, and make it work if possible. The prospect depressed me, but I drew a deep breath, the way you do before you jump into a deep pit of New Orleans molasses, shut my eyes and——

First, and least awful, in my ignorance I thought, came the construction of my antenna. That I felt sure that I could accomplish. After a scientific inspection of my roof (it was Civil Engineering, you know, I studied) I decided on a double sixty-foot affair, with lovely spreaders and turnbuckles complete just like the pictures.

Reader, gentle reader, have you ever tried to measure off sixty feet of hardened, agile, springily-writhing wire in a dining room bedecked with rare and costly china? That wiry serpent of copper was everywhere at once; it was death-dealing. And when, at last, I had swept up the broken vases and Florentine glass candlesticks, and, with my weak, childish hands had painfully, patiently bent backwards each lithe, persistent curve, I was confronted with the task of joining the lead-in and soldering the connections.

Now the brass soldering irons to be found at the ten-cent store, I cannot conscientiously recommend. Not, that is, if you intend to construct the neat, professional joints so eloquently described in Mr. Cockaday's radio book, as a part of an elegant museum piece. Still, if, like a man with a moustache cup, you prefer practicality to beauty, and follow my own artless technique, you will find a ten-cent affair as good as any. You scissor out, then, a little trough of tin. You place in its protecting walls your not-too-pretty connection. You heat your iron to a forbidden red, and you melt rosin and solder over and into that joint in one solid, primordial gob. Of course it takes time. A hot night in July, it was. The kitchen was small— But at last the deed was done. It was not graceful like the gazelle, but it was strong, like a woodchuck. Any truant ions or electrons would have a hard time escaping from that junk of solder. Whew!

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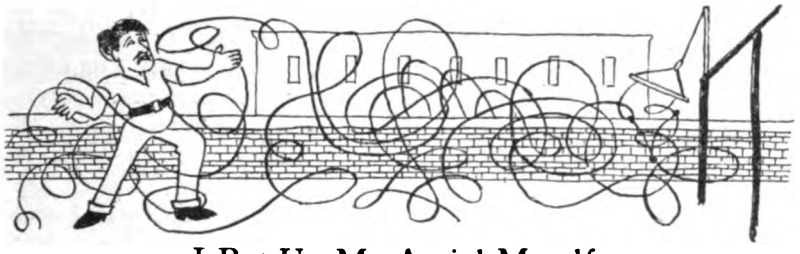

I Put Up My Aerial Myself

I tried to straighten out the puzzle—a complicated arrangement of coils of wire as self-willed as eels.

I now was the proud possessor of a complicated arrangement of three coils of wire as temperamental and self-willed as eels. This, somehow, with curses, I transported to the roof where, under a smiling sun, I attempted to straighten out the puzzle.

Well, I have rowed a boat against wind and an ebb tide round a rocky point. Five pieces of a broken china plate I have cemented together at one masterful operation. I have succeeded in stage-managing three pretty and quick-witted sweethearts at the same time, and kept them all apart. But, for vicious, versatile and vermicular cussedness, give me three snaky coils of hardened copper wire fighting like Kilkenny cats.

"Darn you," said I, "I'll quail your temper, I'll stretch you flat, I'll pin you to those darned spreaders!"

And I did.

I wired one end to an unwilling brick chimney, and one to an impermissible iron fence. I got them both taut, and approximately of equal length before any fire commissioners could hinder me. But radio is hot work. It is dirty work. It is a nightmare.

A hole straight through the window sash I boldly bored. The landlord had raised my rent, and I was going to move, anyway. Then, with a sigh and a broom, I captured the dangling lead-in, and with trembling but dirty fingers I attached it to the binding post.

All was now ready for the "A" battery. Four dry-cells, the directions said, would be sufficient. Mine required eight. The first four, I found, were by this time almost hot enough to fry eggs on; and by the time I had discovered why—that the two terminals had met, embraced and made eager, tropical love to each other for some hours—their passion had completely exhausted them.

By all the rules of the amateur game, I suppose, I should now, after coupling up, have taken down my telephone and heard—nothing. Then, after a disappointed silence I should have toiled and tinkered for hours before the first sound came. Alas, I was not to get my story so easily. The moment I capped my head with that telephone, lo! I heard a lordly voice announcing. "The next musical selection will be—" and, obedient to his invocation, to my delighted ears a lively fox-trot came dancing in over the wires. The darned thing actually worked! I began to lose a little of my awe for that match box radio boy. I, too, could achieve.

For a week I listened to fox-trots mild but persistent. My sister listened. Even the Patagonian maid listened until on the third day she tempestuously refused to be lured to the radio more. "Aw, I ban got a phonograft by my house home!" said declared, "fox-trots we got by the dozens already without no scratches yet."

And then came another installment of my set, a wondrous two-step amplifier that raised those fox-trots from *piano* to *forte,* sent them fairly crashing into

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my ears. Twirl that rheostat as I might, from 1 to 100, I couldn't discourage them. The twin boxes were full of them—running over. I heard them at 10 P.M., weary and ill at ease; and I heard them coffee cup in hand at 9 A.M. I was soon sure that I had already received my $150 worth of fox-trots; but still they came.

Having thus won the victory single-handed as an electrical boob, I now consented to have in an expert to examine my work and show me just exactly what a fool I was. He came. Bearing a heavy storage battery he came, imploring me to help him lug it in. He staggering, almost exhausted, at one handle, and I tugging heroically at the other, we managed to get it into the room. It must have weighed at least ten pounds.

Then he sat him down to rest. He wrenched off a beautiful blue paper shade I had made for my glaring vacuum tube. He crushed it thoughtfully to pieces. Professionally he began to twirl the black knobs. He stopped. He scowled.

"Say, that rheostat sticks," said he. "And that three-way switch is no use at all. The thing's all wrong, see? Those clips don't hold the coils fast, do they? Pretty bum set. We had to fire our engineer, you know, and get another. Why, you can't tune the antenna at all with this—only the secondary coil. I'll have to send you a condenser to put on the aerial side."

"But it seems to work, though," I ventured, timidly, "Don't you hear that fox-trot?"

And, after I had hitched up the new condenser he sent next day, even that seemed to be wrong, too. I could still hear those fox-trots.

Any amateur will of course see at once what had happened. I had made connections with WJZ. That usually means imprisonment for life.

For, to every one of the tens of thousands of radio fans in and about Greater New York, WJZ and WEAF are the Gods of the electro-aerial universe. They are omnipresent, omniscient, omnipotent, paramount, and supreme, drowning out all electrical competition. When WJZ and WEAF speak, all other waves are impotent. Garrulous on the grand scale, continuous, consecutive and consummate, like a he-talker in a club, always on the job, heeding neither applause nor objections, they hourly shoot forth their indomitable, irresistible rays of information, entertainment and fashion hints. For WJZ and WEAF radio sets are bought and thousands sit up on warm evenings with receivers to their eager ears to hear fox-trots and how little Bessie Butterfly flew over the butter.

And, like a high priest at this mass of sound, dignified as an electric refrigerator, calm as a heavenly traffic cop regulating the auto-waves along 360th Street, presides a heroic personage at WJZ, one OLN, breathing his stately, syllabified dicta into the immeasurable voids of space with a voice like the Angel Gabriel or E. H. Sothern.

Once in London, long, long ago, I came across one of those soap-box fanatics who, in Hyde Park, abound in elocution and whiskers. He was an opinionated old bird; but all I remember of his verbiage was this: "I don't hate God; I like him."

And so, I don't really hate OLN. But, at times, listening to his deliberate, cold-blooded edicts, his massive, preternatural equipoise, when, as Master of the Fox Trots, he augustly superintends his concerts, I cannot quite feel that he is mortal. He is too far from life's vicissitudes, too unconscious of care or temper or stomach aches. I almost long, sometimes, to have someone stick a pin into OLN, and bring forth at least one nervous, human *cri-de-coeur*. Anything with a Gosh or a Darn in it would reconcile me to his infinite calm. But I am sure it would do no good. I am sure his mother taught him, when

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angry, always to count ten before speaking.

Least of all, perhaps, I care for OLN when he announces the weather predictions. He has the stoic phlegm of a mastodon.

"Thurs-day . . . . . fair . . . .Fri- - -day . . . . part- - - ly. . . cloudy . . . . with . . . .south . . . . west . . . .winds."

It is almost unbearable, his deliberation. And, when you think that at last the tooth is out and you can try to forget his sempeternal serenity, comes the horrible threat:

"I will repeat . . . . Thurs- - - day . . . ."

and I slam down my telephone, turn off the lamps and crawl wretchedly to bed and try to forget.

New visitors, however, at last began to arrive. After setting up a new and exquisitely soldered 40-foot double aerial on the roof, WOR and WVP and WAAM favored me with an entirely new and fervid selection of phonographic fox-trots. And a mysterious 2XR began to count, rhythmically, "One, two, three, four. . . . . " up to ten; and then backwards to one again. It disturbed me, this message; it was undoubtedly a communication in cipher, and should be promptly looked into by the police or federal authorities. It sounded to me as if someone were counting cases of wood alchohol whisky.

Also, like a string of boys playing leapfrog right through a circus procession of elephants, ever and anon came code messages, in snarling or bleating dots and dashes of all pitch, punctuating the ubiquitous fox-trots. The alluring secrecy of those Morse characters —I got them on all coils, the big, fat 250 and the thin anæmic little 25—high, tin pan, soprano dashes, to wooden, barytone dots—made me increasingly desirous of hearing the talking amateurs.

Strange provocative tales I had heard, of men proposing to women by radio, and being picked up and accepted by a dozen beautiful girls at once. Ladies,

From a photograph made for POPULAR RADIO

I Become a Wire Tamer

Have you ever tried to measure off sixty feet of agile, springily-writhing wire in a dining room? I have.

I read, often made rash confessions into the ambient air, to be jeered at by inquisitive listeners. Where was all this airy conversation, I wondered. Why didn't a few delicious indiscretions come trickling into my set between the fox-trots and baseball scores and stock quotations?

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My friend the expert shook his Solomon-wise head. "Probably your aerial is too long to pick up the waves the amateurs use," he said. "You might try cutting it down."

Cutting it down! That's what I've been doing ever since.

First, I nipped off my 40-foot double wire to 23 feet. Well, a few more amateurs did indeed consent to entertain me, but I found them dull. Mainly, two men I got to know as Frank and Bill.

"All right . . . now try the other plate condenser . . . go ahead." And, after impatiently eavesdropping for ten weary minutes, I was rewarded with an "All right, I get about 265. What you say? No, I don't get your voice yet. Go ahead!" A long, dismal silence while I read how two girls made a pocket radio outfit out of hairpins, very discouraging. Then, "Say, feller with a buzzer on the same wave you are. Try No. 2. All right, go ahead." No, I didn't much care for Bill.

Alas for romance! Never once a feminine voice. Night after night I tuned in and listened, night after night of fox-trots and Condition of the Steel Trade, and then—Oh, that night! Was all my waiting at last to be rewarded? Out of the stillness and the dark, through secret fastnesses of air came:

"Hello, sweetheart! Hello, sweetheart! Sweetheart, sweetheart! haloooooooooo, sweetheart!" clear and haunting.

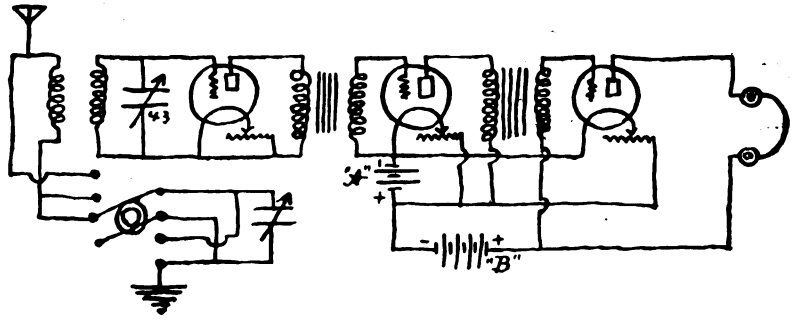
Sssh! Adventure had visited me. Sitting alone, miles away, or perhaps only two blocks, I was to partake, unasked, of an amorous dialogue. Separated by space, yet cooing happily together on the same sweet wave were two fond lovers—and then—

"Hello, sweetheart! On board the *Sweetheart!* Calling Dr. Burkhart on board the yacht *Sweetheart!* Confound you, if you don't answer pretty damned quick I'm going to turn off, *Sweetheart!*"

No, the nearest I got to poetic eavesdropping was when I heard 2CBY calling. He was calling 2CMG; and if 2CMG is not a woman, and a pretty one, I don't want to know it. Please don't tell me. I prefer to believe that, when 2CBY said, "I'll meet you at George's. I'll motor round and blow my horn outside. O.K., 2CMG, what'd you say? Oh, I'll be right over,"—it was nothing less prosaic than an elopement.

Evidently, however, these small time radiobugs used short antennas, as my expert had so cleverly guessed. And so, to sift them out from the fox-trots, I decided to cut down my aerial again —this time to ten feet.

But why bother to put them way up on the roof? My dining room was seventeen feet long, and electric waves could go right through anything, couldn't



THIS IS HOW THE DARNED THING SHOULD LOOK

According to the Technical Expert. But where were those fascinating coiled snakes? Where those arrows shooting northeast? A few bird-cages and mouse-traps I found, and worm-like wires only!

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they? They could even go through the insulation on wires that was put on to keep the electricity in. And so, rather decoratively, from wall to wall, I hung a four-wire, ten-foot aerial from the picture mouldings, making the room like an aviary or angel trap.

No painstaking niceties, this time. Long ago I had abandoned both plain and fancy soldering. I merely twisted the wires together. If I had just hooked them, or stuck them together with chewing gum, I knew that my long-suffering, marvelous set wouldn't mind at all. Insulators? I doubted if even they were necessary; my good old vacuum tubes would stand for anything. But anyway, I'd never pay fifteen cents apiece. Why wouldn't sarsaparilla bottles do? They did. Round their pretty unsuspicious blue necks I softly tied a cotton string and soaked it in wood alcohol. I touched a lighted match and let Nature take its course. Snap! Off went their heads. This piece of practical electrical engineering, however, I did not learn at the Tech. I got it out of Hostetter's Almanac.

My two-step amplifier just fell in love with this inside aerial. Fox-trots came floating in over those ten-foot wires as nimbly as with the ponderous contraption on the roof. How in the world was I ever going to keep them out of the house?

I grew desperate. I'd beat those fox-trots if it took a year. How much abuse would the set stand, anyway? What was its speed limit? And so, to show it I meant business, I rigged up a baby aerial. Only three feet long, it was. "There!" I said to those three black boxes, I guess that'll hold you. Don't you *dare* work! Then I coupled up and listened. Blithely as ever a fox-trot greeted my shocked, incredulous ears.

Would nothing faze that set? The thing was incredible. I had taken every mean advantage of its confidence, but it was like a peevish wife who hangs

I BECOME AN AERIAL

The horrible truth is borne in upon me that I myself, have become a part of the mysterious apparatus as the waves flow through me.

on just for spite and *won't* get a divorce. I would have to resort to cruelty. Savagely, I decided to amputate.

No lead-in, now. Into the binding post I screwed a single wire, just two feet long. Lonesomely it stuck out into the empty air. But, at the first turn of the rheostat, those fox-trots, only slightly chastened, came. Then one foot of wire I tried. Diminished, as if far away, or half asleep, came the too familiar strains. Exhausted, I tried nine short inches, a mere little finger of wire—naked, No. 14 wire, only nine inches long. Weak, but still hellishly cheerful that fox-trot lived and sang.

Eight inches. At last, thank God, it had died away.

Eureka! I had at last conquered. I had forced that darned set to strike. But, just as I was taking that final wire away—hark, what was that? Like a ghost came those merry cadences. That fox-trot, like a skinned eel, was still alive and wriggling. Infuriated, I threw the wire out the window. All was still.

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But then, my fingers still lingering on the binding post, came the final miracle. Listen; as an honest boob, I swear that, with no aerial whatever, no lead-in, no spreaders, no insulators, no anything but your humble servant, I heard again that same old immortal tune! Through my own arm and fingers—horrible though it sounds—that fox-trot was pulsing out of my demonaic machine.

At my frantic telephone call—as one who summons the Society for Psychical Research to announce a new spook—my expert tried to calm me by telling me that I had become the "ground" and the radiator was now my aerial. But I knew better. Hadn't I stood, the while, in two expensive Canton china soup plates and still heard the unspeakable thing? No, the truth was borne in upon me, and I had to accept it, like an attack of measles. I was a part of that magic machine. I had become my own aerial. My fingers were mere antennas.

And so, you see, as I told you, you simply can't own a radio set without learning something about electricity. Perhaps, after all, it is I, and not that match box boy, who should have a statue erected to my genius. For I had demonstrated what the Institute of Technology had taught me, that electricity belonged, really, not in my brain. It belonged in my wonderful fingers.

There remains but one step more. I dare not take it, I might poison a faithful dog, or torture an innocent blue-eyed baby, but my long-suffering receiver has so touched me with its pathetic willingness to serve that I shrink from putting it to the test. Let me keep my faith in it without proof, then, for I am sure that, though I smashed all its vacuum tubes, busted the rheostat, and abolished the storage battery, like the departed spirit of some loyal friend, WJZ's fox-trots would somehow find a way to communicate with me from Newark.

And, frankly, that's precisely why I dare not try it.

Dear reader, I was given this story to write as an ignoramus. "You'll have lots of trouble," said the editor, "and it ought to be funny." Well, as you see, I've failed, miserably failed. I haven't had any trouble at all. In spite of every outrage inflicted upon it that darned set has always worked. Frank and Bill and Joe, every night, juggle wretchedly upon their sets. "All right," I hear them calling, "Now try it on No. 2. No, I don't get that, sounds thick. Go ahead." On the roof opposite, I have watched two boys putting and taking their antennas a dozen times. The newspapers are full of anxious queries about variocouplers and things that don't work. But I have had no such luck, and I tinker no more. I simply can't make it fail.

And so, reader, I ask you: Doesn't that prove that I am a *bona fide* ignoramus?

How I Built a Crystal Set for $12.00, Though I Am 34 Years Old

If you have ever built your own radio set, you know something of the trials and humors that confront the novice at his first attempt. And if you haven't, you can learn about them from DON HEROLD, *the well-known humorist—who will take the readers of* POPULAR RADIO *into his confidence in a near issue.*

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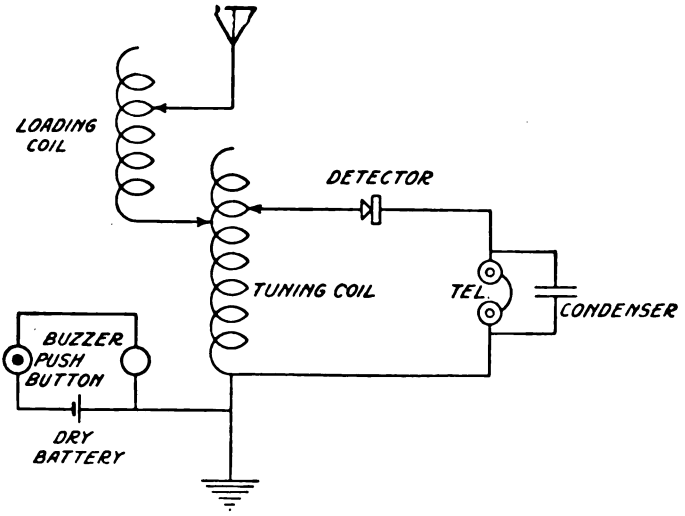

CONDUCTIVELY COUPLED CRYSTAL SET WITH LOADING COIL AND BUZZER TEST

Cost of parts: Not more than $14.00.
Selectivity: Fair.
Operation: Simple. The buzzer test simplifies the adjustment of the crystal detector.
Ease of construction: Not difficult. The whole set can be mounted on a board and wired up ready for use in an hour or so.
Approximate range: 15 miles.
Outstanding feature: A simple set for a young beginner to help him obtain his first knowledge of radio.

100 BEST HOOK-UPS

INSTALLMENT NO. 5

IN this series of hook-ups is being published—for the special benefit of the radio novice who is undecided as to just what circuit he wants—100 of the best radio receiving circuits, each thoroughly tested. The approximate ranges given here are averages based on actual records made with receiving sets throughout the country. During the summer the actual ranges may fall to 50 percent of the value given, while in the winter, in the best of conditions, the actual ranges may exceed the values given by as much as 500 percent. All of these circuits have been described in detail in previous issues of POPULAR RADIO.

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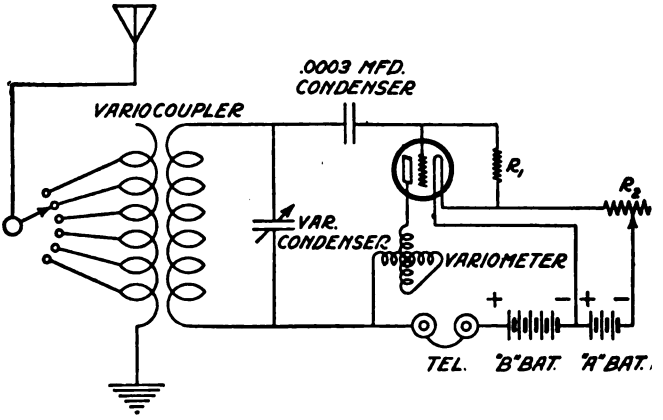
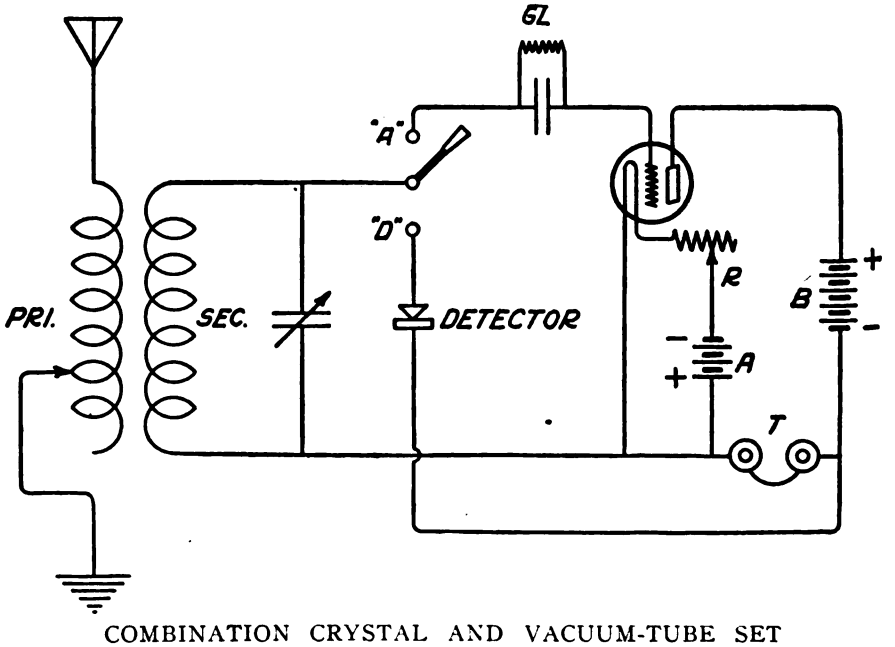


TUNED-PLATE ULTRA-AUDION CIRCUIT

Cost of parts: Not more than $23.00. (Note: The costs of tubes and batteries are considered "extras" and are not included in the costs given in these descriptions.)
Selectivity: Excellent.
Operation: Fairly simple.
Ease of construction: Not complicated.*
Approximate range: 1,000 miles.
Outstanding features: Noted for DX, amateur and broadcast reception and for its exceptionally sharp tuning.

(See POPULAR RADIO, September, 1922, page 62, for constructional details.)



COMBINATION CRYSTAL AND VACUUM-TUBE SET

Cost of parts: Not more than $21.00.
Selectivity: Fairly good.
Operation: Very simple.
Ease of construction: Simple to make.*
Approximate range: 15 miles on the crystal detector. 100 miles on the vacuum-tube detector.
Outstanding features: Here is the circuit for the man who already has a crystal receiver and wishes to find out what the vacuum-tube detector will do for him in the way of increased signals. The crystal may be used for strong local stations and the vacuum tube may be used for the more distant and weaker ones.

(See POPULAR RADIO, July, 1922, page 222, for information about use.)

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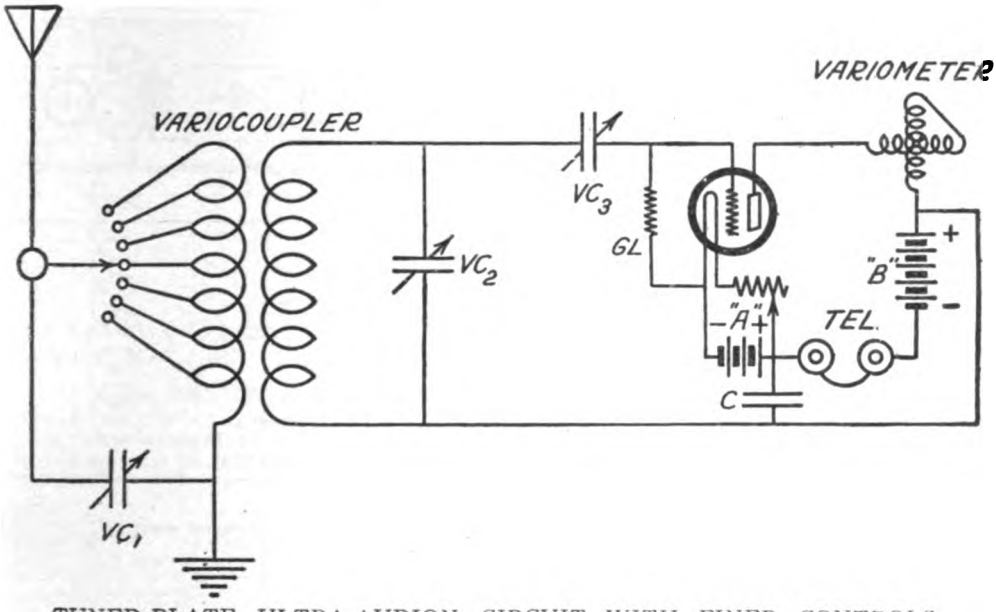
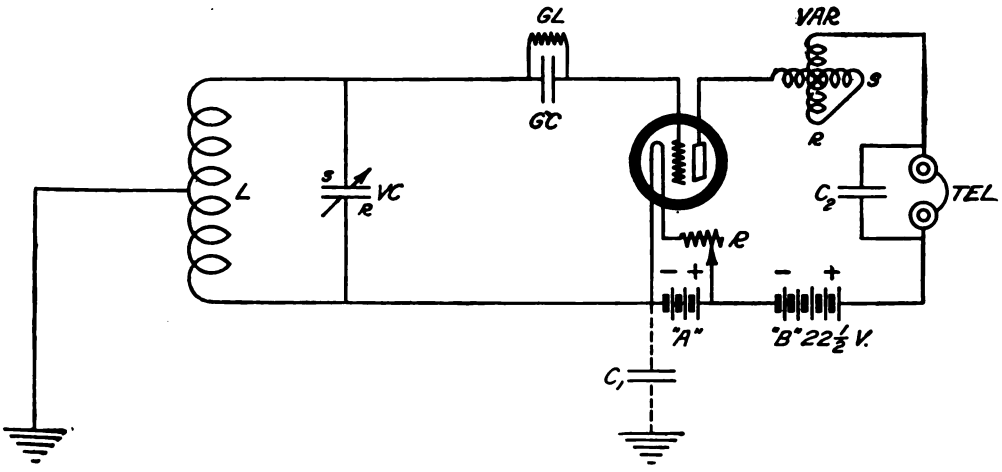


TUNED-PLATE ULTRA-AUDION CIRCUIT WITH FINER CONTROLS

Cost of parts: Not more than $34.00.
Selectivity: Excellent.
Operation: Fairly simple. This adaptation of this circuit contains variable tuning elements such as a variable grid condenser, variable grid-leak, and a variable condenser in the antenna circuit which will enable the more experienced operator to get maximum results out of the receiver.
Ease of construction: Just an ordinary acquaintance with tools and some ability in wiring up the circuit are necessary.*
Approximate range: 1,000 miles.
Outstanding features: A real set for the advanced man who wants selectivity and sensitivity at reasonable cost.

*(See POPULAR RADIO, *February, 1923, page 142, for constructional details.)*



ANTENNALESS REGENERATIVE CIRCUIT

Cost of parts: Not more than $21.00.
Selectivity: Excellent.
Operation: Very simple. One control for wavelength and one for regeneration.
Ease of construction: Not difficult to make.*
Approximate range: 20 miles.
Outstanding features: Works without an antenna. Reduction in static. Fine for local reception.

*(See POPULAR RADIO, *November, 1923, page 372, for constructional details.)*

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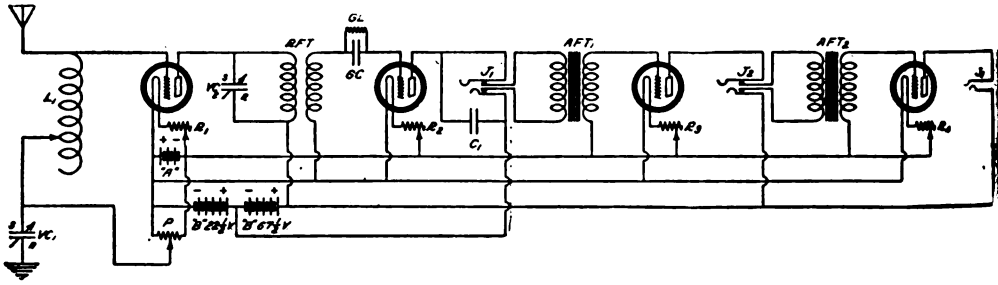
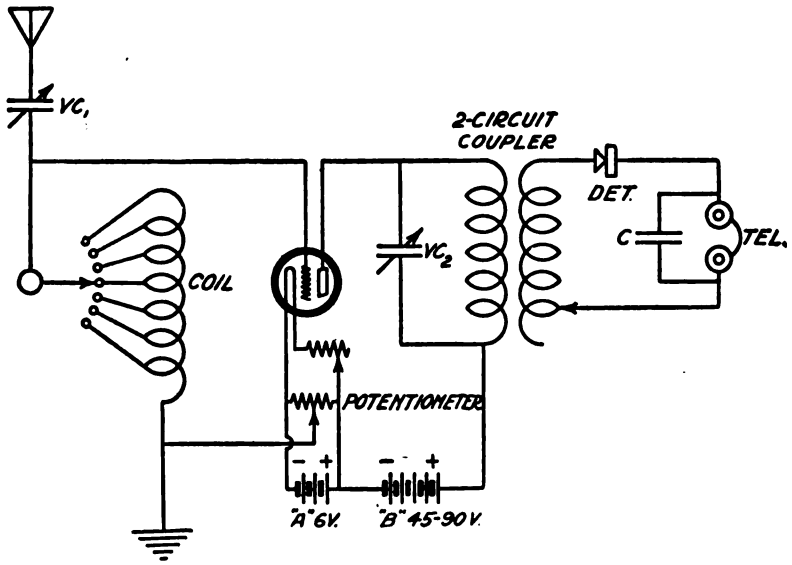


SINGLE-STAGE RADIO-FREQUENCY AMPLIFIER WITH TUNED-PLATE CIRCUIT DETECTOR, AND TWO-STAGE AUDIO-FREQUENCY AMPLIFIER

Cost of parts: Not more than $45.00.
Selectivity: Very good.
Operation: Simple.
Ease of construction: Not any more complicated than the regular regenerative 3-tube circuit.*
Approximate range: 2,000 miles.
Outstanding features: Particularly good for DX reception of broadcasting. Simple to handle and truthful in reproduction of musical programs.

*(See POPULAR RADIO, November, 1923, page 420, for constructional details.)



SINGLE-STAGE RADIO-FREQUENCY AMPLIFIER WITH CRYSTAL DETECTOR

Cost of parts: Not more than $26.00.
Selectivity: Fairly good.
Operation: Not complicated. There are two controls for antenna wavelength, a variable condenser and a tapped coil. The plate circuit is tuned by a second variable condenser, and the inductance tap on the secondary of the 2-circuit coupler controls the wavelength of the crystal circuit.
Ease of construction: Just an ordinary acquaintance with tools and some ability in wiring up the set are necessary.*
Approximate range: 500 miles.
Outstanding features: Clear, crisp reception. A short antenna may be used (such as an indoor antenna strung behind the picture molding).

*(See POPULAR RADIO, February, 1923, page 142, for constructional details.)

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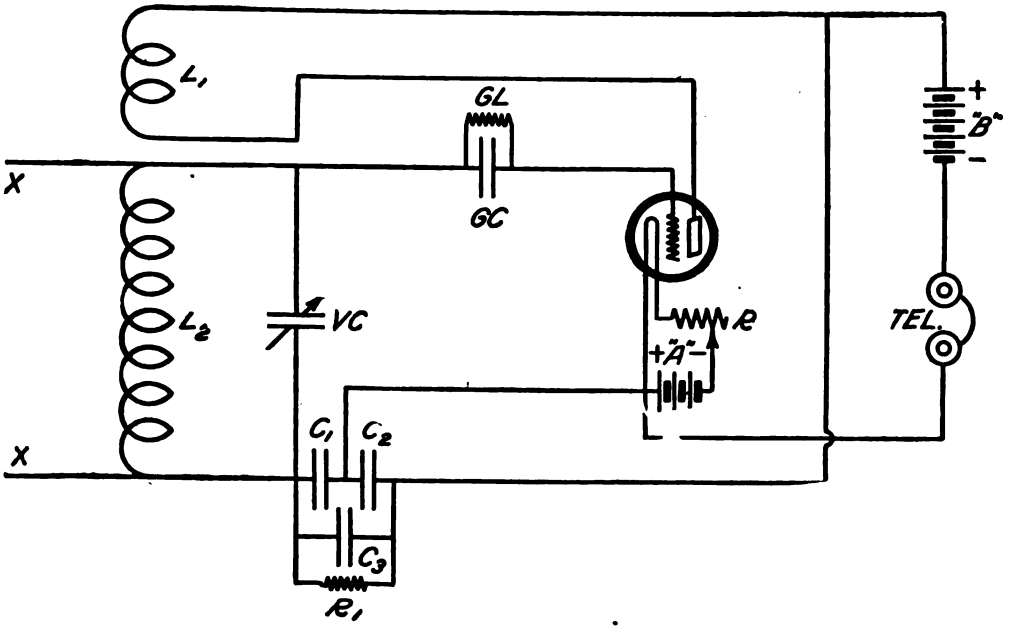
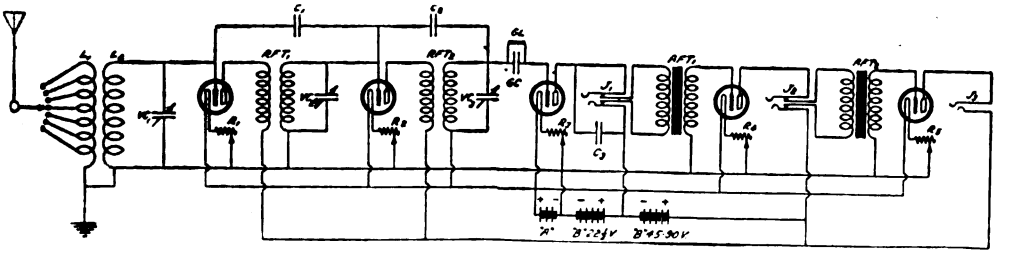


FLEWELLING MODIFIED SUPER-REGENERATIVE CIRCUIT

Cost of parts: Not more than $22.00.
Selectivity: Fair (on outdoor antenna). Good (on loop).
Operation: Not hard to operate when the circuit has once been adjusted properly. When used on an outdoor antenna, however, it is liable to produce bad interference to neighbors, due to re-radiation.
Ease of construction: Easy to make but not easy to get adjusted right.*
Approximate range: Local (on loop). 500 miles (on an outdoor antenna).
Outstanding features: Simplest super-regenerative circuit. Can be made to operate a loudspeaker on one tube. This is only true when all conditions are satisfied. Actually, many experimenters do not get very good results on account of some mistakes they have made and have failed to locate. Reception is accompanied with a high-pitched whistle.

(See POPULAR RADIO, May, 1923, page 393, for constructional details.)



FIVE-TUBE NEUTRODYNE

Cost of parts: Not more than $60.00.
Selectivity: Very good. There are three controls for wavelength.
Operation: Simple, if the set is tuned by means of a chart. In fact this is the only way to tune this receiver successfully.
Ease of construction: More or less complicated. There are a number of precautions that must be taken to get the circuit to function properly, especially in the matter of eliminating feedback. The set will operate more efficiently when the neutralizing condensers are upset slightly so that the set will regenerate without readily bursting into uncontrolled oscillation.*
Approximate range: 2,400 miles.
Outstanding features: The wavelength can be calibrated. The set will not re-radiate. Anyone can operate the set by means of the tuning chart.

(See POPULAR RADIO, September, 1923, page 248, for constructional details.)

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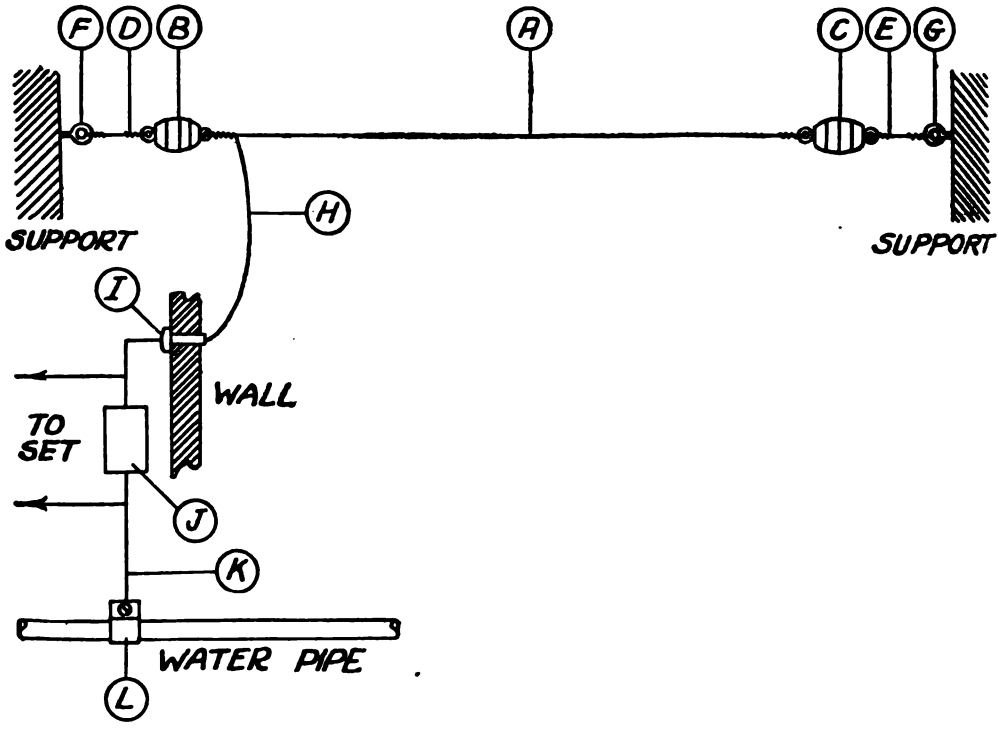

THE DETAILS FOR THE SINGLE-WIRE ANTENNA

FIGURE 1: *This schematic diagram shows how to install a receiving antenna from the water-pipe ground to the farthest support. All parts for the antenna are designated by letters which reappear in the text and the list of parts so that you can make no mistake.*

HOW TO PUT UP AN

OUTDOOR RECEIVING ANTENNA

By ALBERT G. CRAIG

Here are the instructions for putting up the standard type of transmitting and receiving antenna such as is required for the successful operation of all of the sets described in this magazine

COSTS OF PARTS: *About $5.00*

HERE ARE THE ITEMS YOU WILL NEED—

Seven-strand, bare-copper wire, size No. 14 (enough for antenna A, supporting wires D and E, lead-in H, and ground lead K);
B and C—glazed porcelain insulators;
F and G—screw eyes;
I—glazed porcelain tube;
J—lightning arrester;
L—ground clamp.

A TRANSMITTING antenna is usually designed to fit the transmitting station, after due consideration has been given to its effective height and length in order to secure maximum radiation. On the other hand, a receiving antenna is often designed to fit the location, which is generally a satisfactory solu-

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tion of the problem, as losses in the receiving antenna may be compensated by amplification, whereas any increase in transmitting power is necessarily costly.

Therefore let us consider the erection of an antenna from this viewpoint, not permitting, however, the use of a design that will cut down the efficiency of the system to an unsatisfactory point.

In general, the selection of a type of antenna for receiving only narrows down to the single or double-wire "L" or "T" type. Both of these types have the same "flat top" approximately parallel to the ground. The "L" type has the lead-in taken from one end, which gives it a resemblance to an inverted L; the "T" type has the lead-in in the center, which gives it the shape of a large T. Both of these types are directional along their length; consequently, if they can be pointed toward the desired transmitting stations, reception will be somewhat increased. On the other hand, a directional antenna will decrease the proportion of static received as these atmospherics come from all directions.

After you have decided on the "L" or "T" antenna (the L type is best for receiving), look over your available locations. If possible find two supports at least 30 feet high which will give an unbroken span of 100 to 150 feet or longer.

Do not run the antenna over or under any high-voltage electric light or power wires.

It will be best if one end (for the "L" antenna) or the center of the span (for the "T" antenna) is exactly over the window nearest the set, thus giving a *direct* lead-in.

Keep the wire at some distance (six feet if possible) from surrounding objects if you want to get the best results. For instance, if it is placed only one foot above a grounded metal roof, it will be practically equivalent to an antenna the same distance above the ground.

While masonry, wooden buildings and trees will not cause as poor results as a steel building, there will be a noticeable loss in signal strength if the antenna is run close to them for any considerable part of its length.

If two natural supports cannot be found to give the required unobstructed span, it will be necessary to provide one or both of them, probably by erecting a short pole. (It may be well to mention the fact that a wire strung back and forth several times to give a total length of 100 feet or a very short multiple-wire antenna containing that amount of wire is usually not at all satisfactory.)

Next, choose a point of entrance for the lead-in wire. This may be in the window frame, in the sash itself, or in the wall nearby.

Then select a ground. The most satisfactory ground is the nearest water pipe. Other less desirable grounds are the iron frame of the building or any large grounded metal system, such as the steam-heating pipes.

Do *not* use the gas pipe for a ground as this is prohibited by the insurance companies.

Now that the general scheme for the entire antenna-ground system has been settled upon, let us consider the required apparatus, all of which is shown in Figure 1.

The antenna wire A, the short lengths of supporting wires D and E, the lead-in wire H, and the ground wire K may all be of seven-strand, bare-copper wire, size No. 14. The antenna insulators B and C should be a good grade of glazed porcelain, often being corrugated to give a longer insulating surface; F and G are two screw eyes large enough to take a firm hold in the antenna supports. The entrance bushing I, is a glazed porcelain tube long enough to pass entirely through the wall or the window sash as the case may be. The

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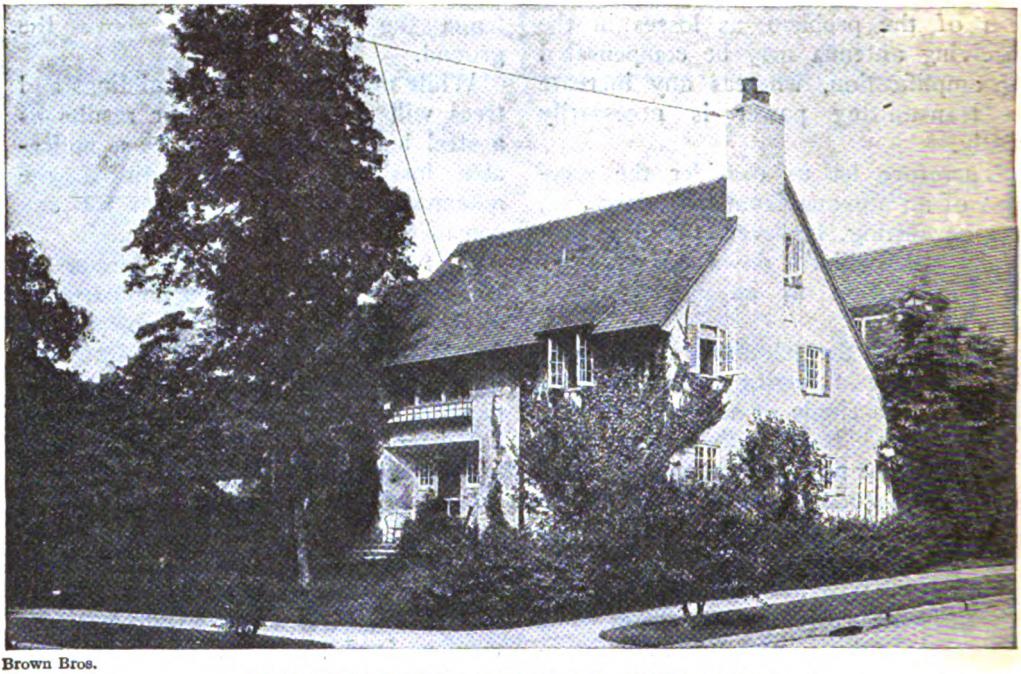

Brown Bros.

THE RECEIVING ANTENNA INSTALLED

FIGURE 2: *This typical installation shows how two natural supports (in this case a chimney and a tree) may be used for the single-wire receiving antenna. For a residence this method of supporting the antenna is much less conspicuous than the use of poles or brackets.*

lightning arrester J, may be one of the small indoor vacuum-gap type and should be marked "Approved by the Underwriters' Laboratories." L is a good grade of ground clamp.

Summing up, it will be necessary to purchase the apparatus specified at the head of this chapter.

We may now proceed with the installation of the antenna.

First put the screw eyes F and G in the two supports. Then attach a one or two-foot length of wire E to insulator C and connect the other end of the wire to screw eye G; connect up insulator B, supporting wire D and screw eye F in the same manner. Note that the length of the supporting wires may have to be increased to clear obstructions. Feed the antenna wire out from the coil through insulator B and attach the free end to insulator C. Draw the wire taut and wrap the coiled end around the antenna wire by passing the entire coil around it about ten times; then uncoil sufficient wire for the lead-in H.

This method makes the antenna and lead-in continuous and saves soldering; with the "T" type antenna it is, of course, impossible to do this and the lead-in must be soldered to the center of the antenna before it is put up.

Next, bore a hole for the lead-in bushing with a slight slope downward toward the outside of the house, so that water will drip off instead of running inside; insert the bushing and pass the lead-in wire through it. Fasten the lightning arrester to the wall nearby and connect the lead-in to the top side of it, then run the wire to the antenna post of the receiving set.

It may be well to caution here that while only two antenna insulators and one porcelain tube have been called for, that some insulation such as a porcelain knob-insulator is necessary if either an-

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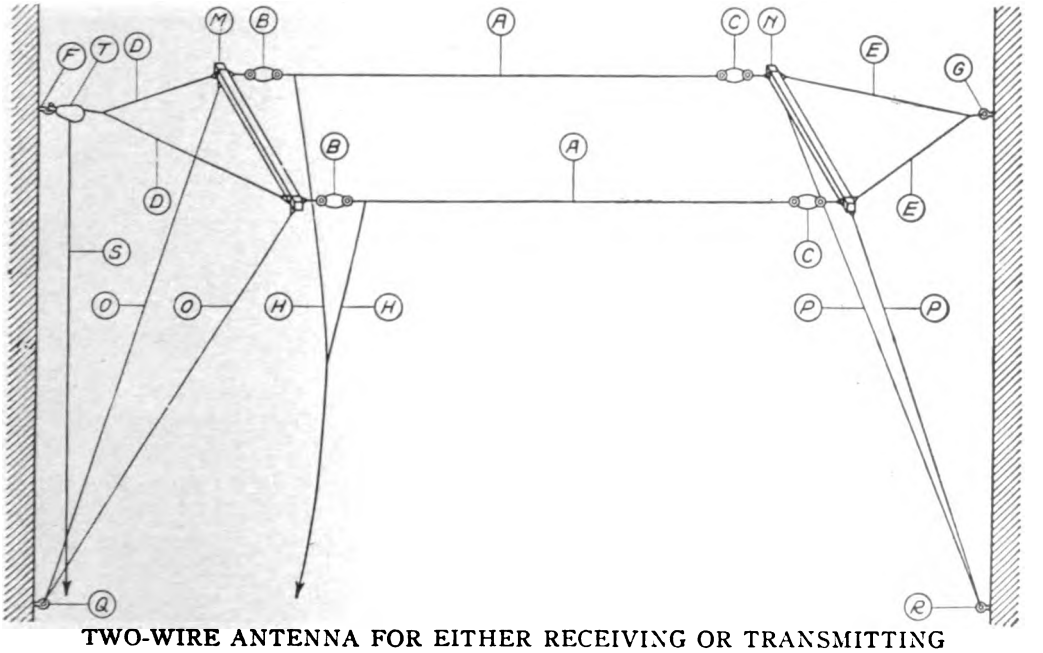
tenna or lead-in touches the house.

Prepare the "ground" by scraping the water pipe thoroughly, then attach the ground clamp and run the ground wire in the most direct line possible from it to the lower side of the lightning arrester, then on to the ground binding post of the receiving set.

Ordinarily the one-wire antenna described here will be perfectly satisfactory, but the two-wire type may serve to bring up some particular station which it is difficult to receive. If the two-wire type is decided upon, consult Figure 3 for the assembly. Provide two hardwood spreaders M and N (two inches square and four feet long), four insulators B and C, one pulley T with a small hook F for fixing same to support, three screw eyes G, Q and R, and enough additional wire for the double antenna, the guy wires O and P, and the pulley wire S.

The two-wire antenna had better be assembled complete on the ground and hoisted into place. First, notch the spreader N about one inch from each end and connect, in the notches, insulators C (by means of a short length of wire), supporting wires E and guy wires P. Join supporting wires E about four or five feet from the spreader and join guy wires P about ten or fifteen feet from the spreader. Connect insulators B, supporting wires D, and guy wires O in the same manner to spreader M. Solder wires H at the ends of the two antenna wires A and bring them together a few feet below the antenna to form a single lead-in. First raise the far end of the antenna into position, connecting supporting wires E to screw eye G; then connect pulley wire S to supporting wires D and raise the other end of the antenna into position. Attach guy wires O to screw eye Q, and guy wires P to screw eye R.

The remainder of the installation is the same as for the single-wire antenna.



TWO-WIRE ANTENNA FOR EITHER RECEIVING OR TRANSMITTING

FIGURE 3: *This diagram gives the specific data for erecting an inverted L-type antenna. The supports may be two poles set up especially for this purpose or they may be two trees or other natural supports. If trees are used the spreaders should be set out about 15 feet from the branches or there will be a certain amount of absorption of energy by the tree.*

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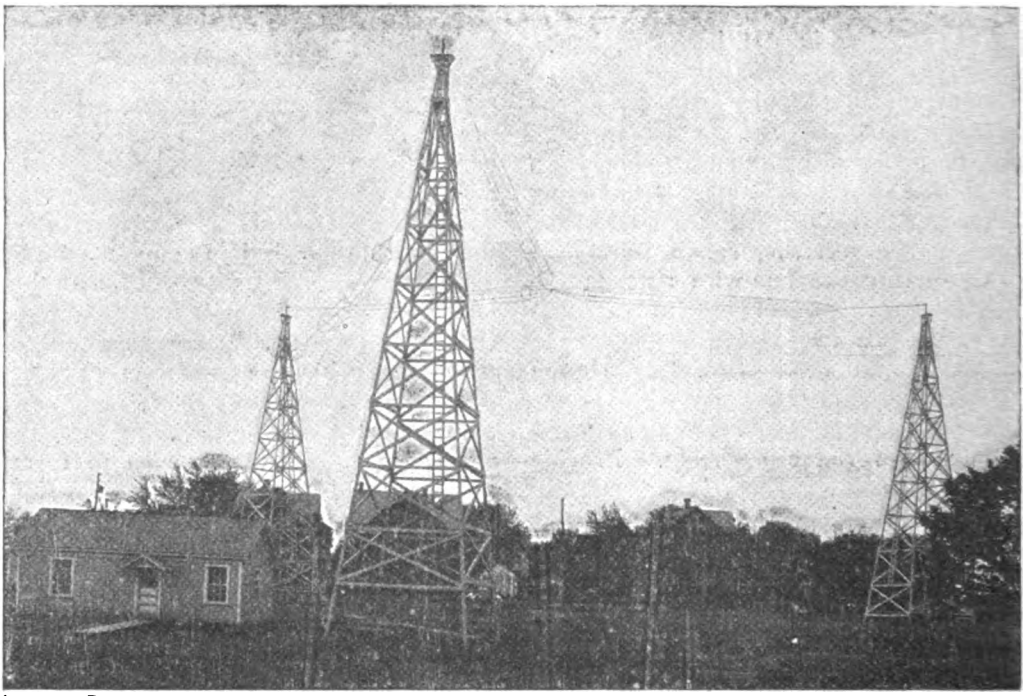

Armstrong Perry

THE BROADCASTING STATION OPERATED BY PENNSYLVANIA STATE COLLEGE

The lecture courses are not confined to small groups of undergraduates; some of them are made available to the people of the entire state through station WPAB

A College with a Radio Faculty

"The need of continuous education is so great, and the necessity for sending out information is so pressing as to make highly desirable some means of popular information in addition to the sometimes long-delaved government bulletin. Radio furnishes the means of reaching this audience quickly and regularly." So states the U. S. Commissioner of Education. This article tells what one of the more progressive colleges is doing to carry this modern idea into effect.

By ARMSTRONG PERRY

THE slogan "The college of the state for the people of the state" led Pennsylvania State College, years ago, to add to its lecture and classroom courses many that any citizen of the state could pursue without leaving his own fireside.

These courses were called "extension courses" and the instruction was given by correspondence. Early in the spring of 1923 inquiries began to come in from Pennsylvanians who wanted radio instruction by mail. The Engineering Extension Department investigated the possibilities of a correspondence course, comprehensive, useful, yet not too difficult for the average man.

A course was prepared. It was announced in short paragraphs in the newspapers of the state and attracted the attention of radio magazines, which made it known nationally. Before any feature article had appeared, inquiries were coming into Penn State by hundreds, and

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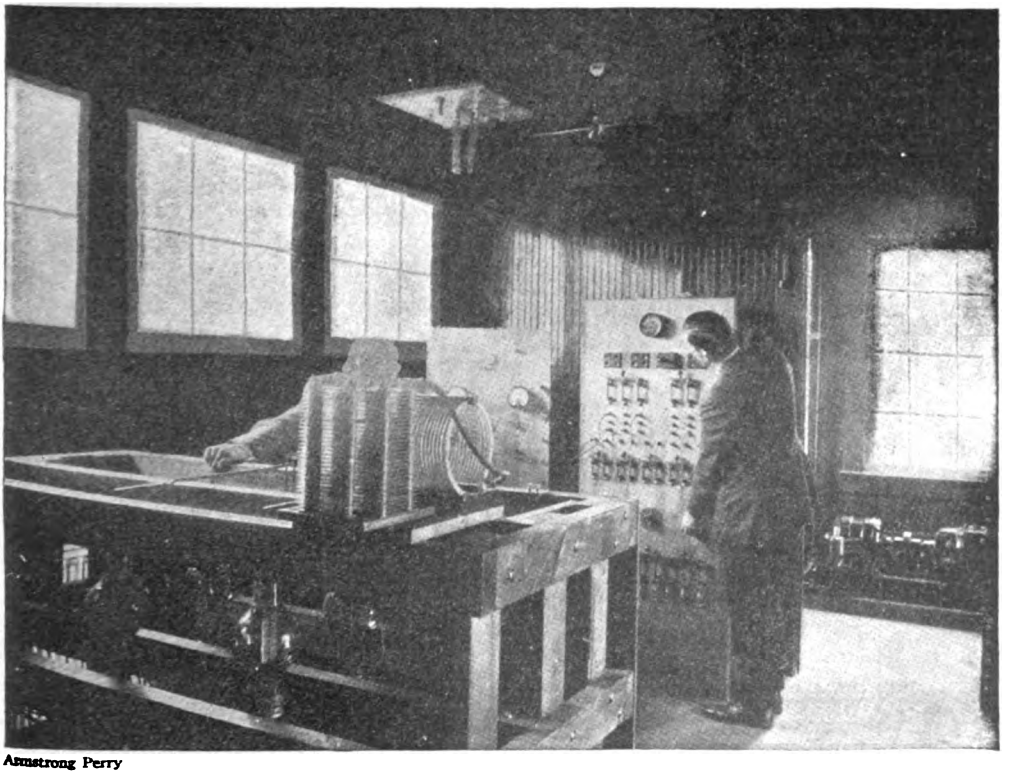
early in the fall the registration exceeded that for any other course offered by the department. At the last report 32 per-cent of the corresponding pupils regis-tered by the Engineering Extension Department were studying radio. Many of them are residents of other states. Every section of the Union is well rep-resented.

The first man to register for radio was a newspaper editor. Several farmers, disproving the alleged slowness of the rural mind, were near the head of the list. Accountants, typists, postal clerks, radio salesmen, mechanics, steel workers, boiler makers, licensed commercial radio operators, a doctor of philosophy and a dentist were among the early applicants. As the enrollment lengthened, all the leading professions and lines of business were represented, and many of the trades. A high-school teacher, intent on organizing a radio club, asked for the assistance that the course would give her in keeping ahead of her pupils in the new subject. An aged physician applied just too late—death overtook him before his first lesson was prepared. His widow wrote that his interest in the marvelous new science was strong until the last. A youth in Montana filled the vacant place. He is but fourteen and the course is not designed for boys, but he showed that he was qualified, even to the securing of his father's permission to add the cor-respondence course to his first year's work in high school. Cubans and Cana-dians have applied for registration.

If the five continents and the islands of the sea have not added their quota of pupils by this time, the mails must have been delayed.



Armstrong Perry

BEHIND THE SCENES IN A MODERN EDUCATIONAL INSTITUTION

Here is the apparatus used for transmitting by radio some of the lectures that supple-ment the correspondence courses maintained by Pennsylvania State College. Part of the generator equipment is seen in the rear.

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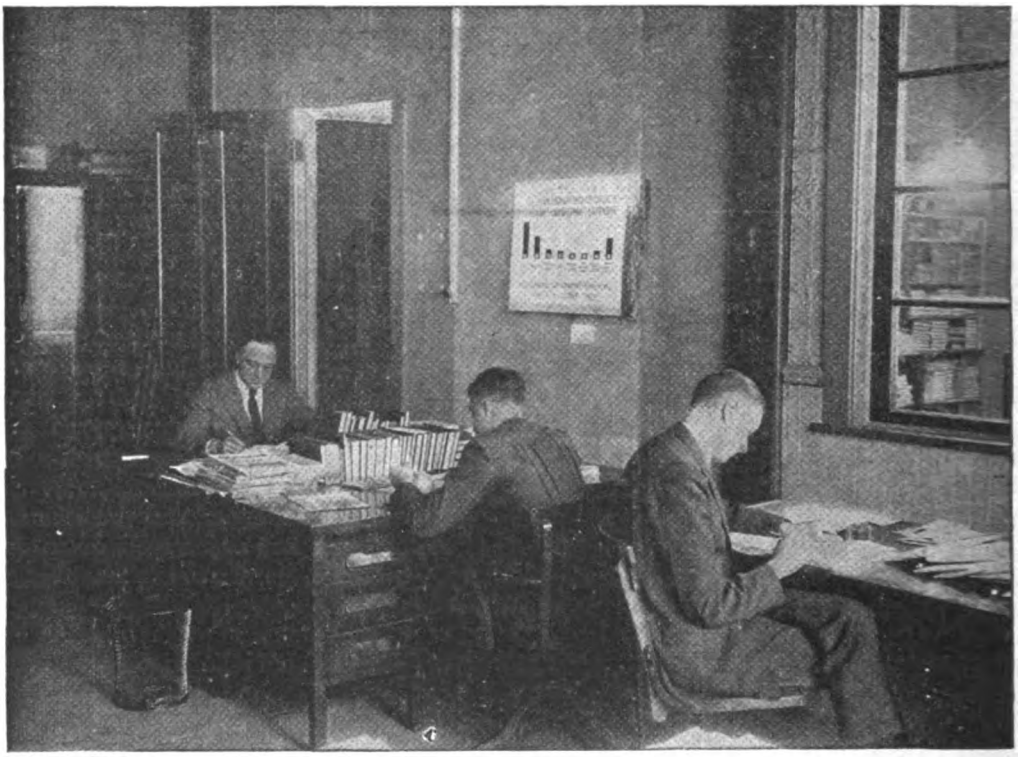

Armstrong Perry

THE "RADIO FACULTY"

Here is Prof. G. C. Gaum (at left), with his two assistants, who is in charge of the courses of instruction conducted both by radio and by correspondence. The chart on the wall shows that the registrations for the radio course overtop all others.

Penn State is well prepared to care for her pupils in the radio correspondence courses—better prepared than she is to admit applicants to her classrooms. Four thousand students have been turned away in seven years for the lack of room. The college has had a radio station since the time, fifteen years ago, when a forward-looking graduating class gave her a 130-foot steel tower for the aerial, and an operating room. For years her station, 8XE, has been one of the reliable relay stations of the American Radio Relay League. It has been heard in all parts of the United States, in the English Channel, in Switzerland and 1,700 miles off our Pacific coast. The professors and pupils have had broadcasting experience also. The alumni residing in the Pittsburgh district gave the money for the installation of a broadcasting station to be used for educational purposes. It opened up last May. The pupils who operate and study it, under the supervision of the radio faculty, gain practical experience while the listeners hear the president, Dr. John M. Thomas, talk on subjects of general interest, the deans of the five colleges tell of the work accomplished in their respective fields, and strong-voiced announcers follow the battles waged on gridiron and diamond.

The broadcasting station, WPAB, adds interest to the work of the men's and women's glee clubs and quartets, the mandolin club, the soloists and the student dance orchestra. Distance lends enchantment, and no matter how the folks back on the farm may have kicked when Bill first tackled the saxophone and Mary hurdled high C, they are

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mighty keen on calling in the neighbors when the kids' college-bred music slides down the antenna and spills out of the loudspeaker. Even in the days before the radio telephone, when the baseball and football scores were sent out in dots and dashes, there were interested listeners all over the state, but under the present method their numbers have multiplied faster than rabbits in a back-yard pen. The programs are adapted to both city and rural residents. All this experience had helped to make the radio correspondence course something more than a mere academic arrangement of dry facts—the professors know what it is to be up against practical situations.

When Farmer Smith cannot separate the cream of the ether from the blue milk, as he sits with his text-book in one hand, his tuning knob in the other, and his ears full of assorted concerts and information from radio stations at all points of the compass, on Penn State's "Farm and Garden Night," the instructor who receives his lesson paper knows just what he is talking about and what advice he needs. If a farmer follows the advice that he receives, he will eventually be able to build his own set (though the course does not cover construction) and bring in the frost warning, the advice on the apple scab that threatens his orchard, and other things broadcast by the college for the fattening of the farmers' pocketbooks.

The correspondence course in radio is under the general supervision of Professor Charles Kinsloe. Professor N. C. Miller of the Department of Engineering Extension, who has specialized in correspondence instruction for the past ten years, has immediate charge of this and other mail courses. Professor C. G. Gaum gives the instruction. He has several assistants. The course is divided into two parts, each with its own text and ten assignment pamphlets. The first part, designed to meet the needs of beginners and amateurs, establishes principles, and studies common electrical phenomena, radio circuits, the vacuum tube, amplification, sources of power, transmission circuits, and applications of radio. The second part delves more deeply into the theory of electricity and leads up to detailed consideration of electromagnetic waves, radio circuits and the apparatus employed in the transmission and reception of radio messages. The first part costs the corresponding student $10.00, and the second part $15.00. Text-books and pamphlets are furnished without additional charge.

"How to build it" has been omitted, after careful consideration, for the pupil can buy such information in the radio books and in the radio periodicals. The instruction given by mail may be supplemented by lectures delivered *via* radio.

Pupils who find it possible to visit the college will find a welcome and see many things that are impressive. The broadcasting station looks dwarfed beneath the towers that support the star-cage antenna, but it contains three ample apartments: one for the studio, one for the operating room and one for the generating plant, which delivers a full kilowatt to a row of 250-watt transmitting tubes. Much of the apparatus has been built by resident students, directed by Gilbert L. Crossley, an undergraduate, and underneath the antenna system is buried, eight feet deep, a ground system with a network of wires.

Will Radio "Revolutionize" Our Educational Methods?

SOME *of the best minds believe that it may—including that of the progressive president of* ***Antioch*** *College, who is making a significant experiment in "broadcasting education" that may lead to far-reaching results.*

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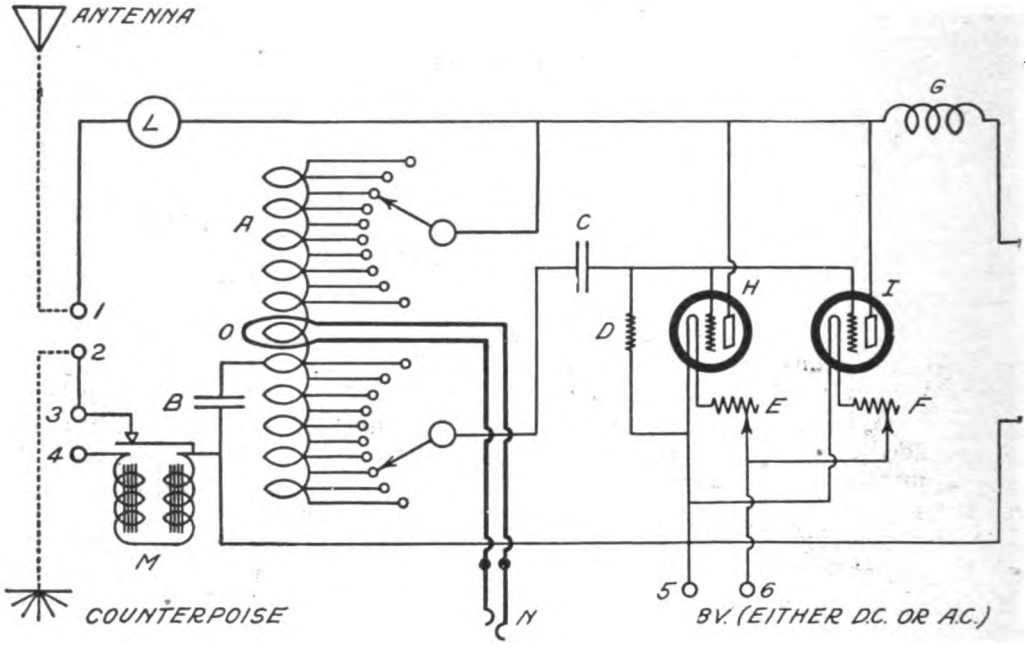

THE ELECTRICAL WIRING DIAGRAM FOR THE TRANSMITTER

FIGURE 1: *This drawing shows how to connect the various instruments and parts in the electrical circuit so that they will function in the manner described in the article.*

HOW TO BUILD

AN AMATEUR TRANSMITTER

By LAURENCE M. COCKADAY, R. E.

COSTS OF PARTS: *About $150.00*

TRANSMITTING RANGE: *About 25 miles*

HERE ARE THE ITEMS YOU WILL NEED—

A—inductance coil (see Figure 5);
B—antenna fixed condenser, .0015 mfd. (Any standard make of high-voltage mica condenser can be used in place of the home-made one);
C—grid condenser, .0008 mfd. (Not critical, a .0005 mfd. can be used);
D—Ward Leonard resistance, 7,000 ohms;
E and F—filament rheostats (resistance values to suit tubes used);
G—honeycomb coil, size L200, used as a radio-frequency choke;
H and I—vacuum tubes, either VT-2 tubes or UV-202 tubes can be used;
J—Acme double-coil iron-core choke, 1½ henries, 150-milliampere carrying capacity;
K—Federal paper condenser, No. 58-B, 2 mfd.;
L—General Radio hot-wire ammeter, scale reading from 0 to 2.5 amperes (for mounting on front of panel);
M—Century buzzer (H-F);
N—single-circuit jack (well-insulated type);
O—single-turn modulating loop wrapped tightly around inductance coil A;
P—composition panel;
two switch levers;
eight binding posts;
twenty switch points and four switch stops;
cabinet;
Esco 350-volt motor generator;
DPDT starting switch, 25-ampere carrying capacity;
connection wire, solder, etc.

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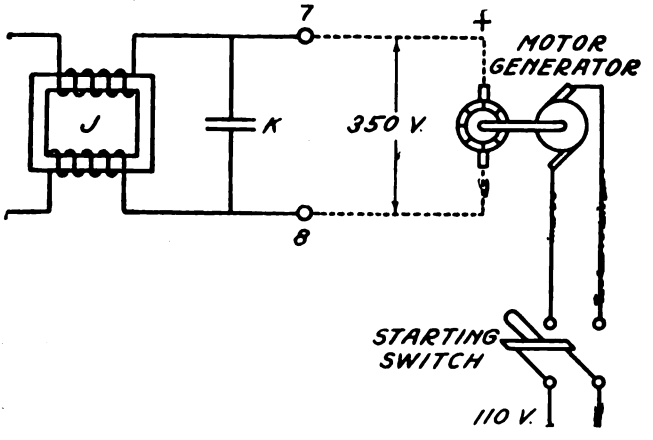

THERE are a number of designs for a small transmitter that could have been picked out for description; there are also a number of circuits that still find each their adherents among the transmitting amateurs. But the author has decided to stick to the circuit known as the Colpitts, as it is so easy to build and to get into operation.

Anyone who is given the description of this set can easily make it and have it working to perfection within a week's time—after he secures the necessary parts.

The transmitter selected consists of two 5-watt tubes, which are mounted in a neat cabinet with the inductance, the filter circuit, the chokes, condensers, and the other pieces of apparatus. The front of the panel will have the controls for the wavelength, the rheostats and the buzzer. The only external apparatus necessary comprises the motor generator, the key, the dry battery for the buzzer and the antenna and counterpoise.

In operation the set should have a range of about twenty-five miles for telephony; about fifty miles with the buzzer and as much as a thousand miles for CW, with a good antenna system and a fair location.

The electrical wiring diagram is shown in Figure 1. The wiring in dotted lines is located outside of the cabinet, as is also the motor generator and the starting switch.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of the transmitter may easily determine how to mount the instruments in the correct places and connect them properly in the electric circuit. The same designating letters are used in the text and in the list of parts at the beginning of the article.

¶ *The list of parts there given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

How to Construct the Set

After procuring all the instruments and materials for building the set, the amateur should set about preparing the panel (shown in Figures 2, 3 and 4).

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First of all the panel should be cut to the correct size, 11 by 15 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 3.

The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next, mount the two rheostats E and F, with two screws each, and attach the two small knobs.

Then fasten on the two switch levers, and the two sets of switch points as shown in Figure 4.

Now mount the hot-wire ammeter L by inserting the two screws on the instrument through the panel and fastening with nuts on the rear. (See Figures 2 and 4.)

Then place the jack N in the hole drilled for it in the panel and fasten tight in the regular manner.

The buzzer M may now be mounted in the position shown in Figure 4, by two screws. The cap of the buzzer will have to be removed for this operation.

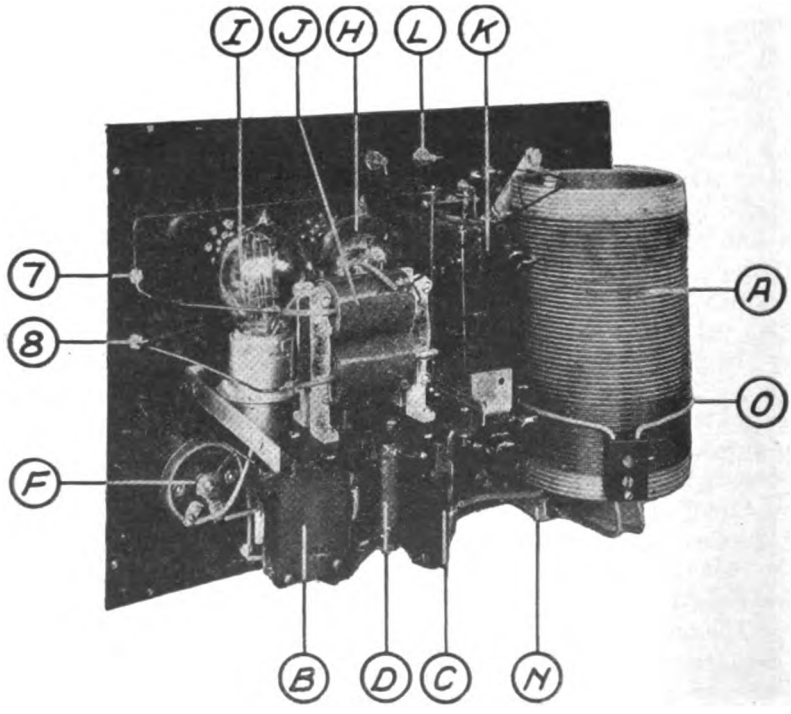
About the only thing left to do on the panel will be to mount the binding posts as indicated in Figure 4.

How to Make the Inductance Coil

Now consider the making of the inductance coil A.

This coil should be wound on a composition tube 4 inches in diameter and 6 inches long. The wire used for the winding is No. 14 bare or enameled copper wire. The turns should be spaced approximately $\frac{1}{16}$ inch apart.

The winding should have ten taps spaced



AN INTERIOR VIEW OF THE SET

FIGURE 2: *This picture shows the general arrangement of the apparatus which is mounted directly on the main panel and on the shelf panel. The parts are designated by letters which reappear in the text and in the list of parts at the head of the article.*

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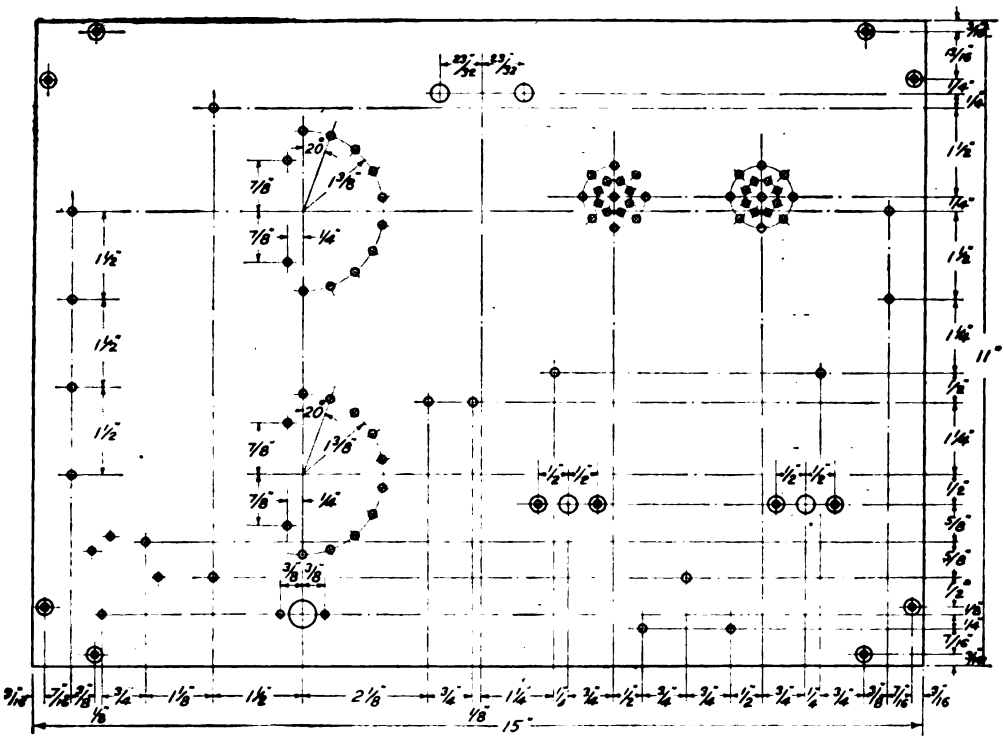

HOW TO PREPARE THE MAIN PANEL

FIGURE 3: *This drawing gives the drilling data for the holes for the screws which are used to support the instruments, switch levers and the binding posts.*

one tap every turn from the bottom of the coil, for the grid voltage control, and ten taps spaced every other turn from the top of the coil, for the wavelength control. The remaining ten turns at the center of the coil are left untapped.

Before winding the coil, the tube on which the coil winding is made should be threaded to fit the wire, the groove being about ⅛ inch wide and deep and having about 8 turns around the coil, to the inch along the coil. This job can be done in a neighboring machine shop at a very small cost to the builder. The wire should be wound tightly in the groove, as shown in Figures 2 and 5, and the taps made as shown in Figure 5.

These taps should be staggered slightly on the coil, and when the coil is completed the taps should be squeezed together so that the wire will pinch tightly against the tube and cause it to bind permanently and securely.

When the coil winding is complete it may then be fastened to the panel along with the other instruments already mounted. The coil is fastened to the panel by two screws as shown in Figures 2 and 4.

How to Make the Fixed Condensers

The next construction job will be to make the two fixed condensers B and C.

These can be made as shown in Figure 6. Two heavy plates of brass (about a quarter of an inch larger all around than the condenser plates) are cut and bent as shown and drilled for 4 screws.

The plates for the grid condenser C consist of two plates of copper foil 1¼ inches square with a connecting flap, and separated from each other by one sheet of mica .003 inch thick by 1½ inches square. The capacity of this condenser should be somewhere in the neighborhood of .0008 mfd.

The antenna condenser B has three plates and is otherwise constructed in the same manner as the first condenser. The two outside copper plates are connected electrically together and form one terminal and the flap on the middle plate forms the other terminal. Of course, the middle plate is insulated from the two outside plates by two squares of .003 inch mica sheet. This condenser may have a capacity of about double that of the condenser C.

The copper plates are insulated in turn from the outer brass pieces by two squares of thin composition sheeting. The whole construction is shown so clearly in Figure 6 that further consideration is unnecessary. However, for those who do not wish to make the condensers, they may be purchased. Just ask for mica condensers of about the capacities specified.

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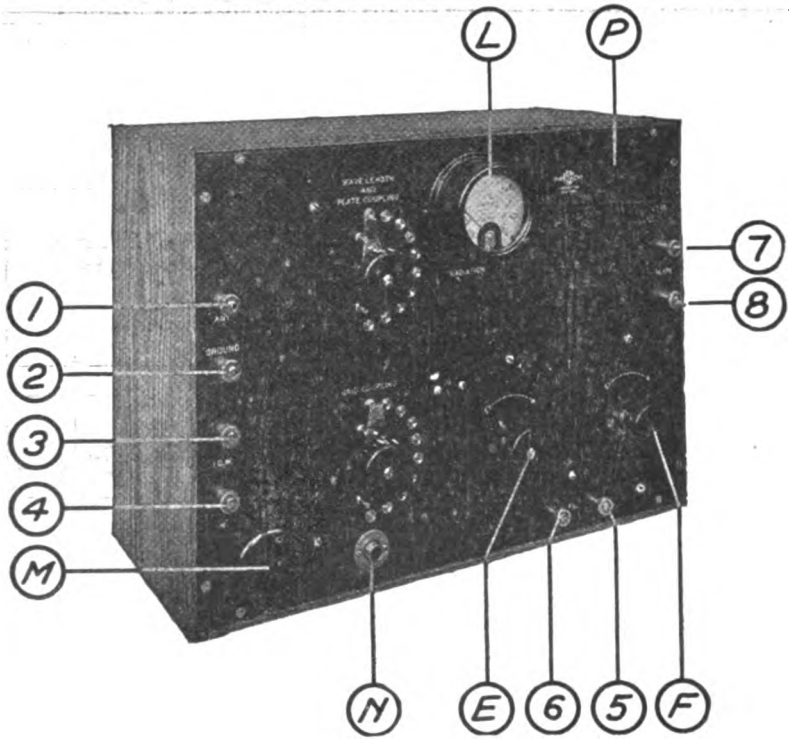

A VIEW OF THE SET FROM THE FRONT

FIGURE 4: *Showing the panel layout with the location of the switches, jack, rheostats, meter, buzzer and the binding posts.*

They *must be* for transmitting purposes.

The small shelf panel should now be cut to size and the three brass brackets made as shown in Figure 7. When this is done the two condensers are mounted underneath it together with the grid-leak D and the radio-frequency choke coil G. On top of this panel should be mounted the two tube sockets and the double-coil, audio-frequency choke J.

This whole shelf-panel assembly is then fastened to the main panel with three flat-head machine screws with nuts on the rear of the panel.

Then, to mount the filter condenser K, another brass bracket will have to be made as shown in Figure 8 and also two strips of composition insulation will have to be cut as shown in the same figure. This drawing shows how the condenser should be mounted and fastened to the panel.

This completes the construction work on the set and it is now ready for wiring.

How to Wire the Transmitter

The set should be wired with care and it would be well if the radio-frequency circuit is connected with the same kind of wire as used for the inductance coil A. This keeps down the resistance of these circuits and therefore, the utmost in power will be supplied to the antenna. No insulating covering should be applied to any of these wires except through the filament circuits. For the audio-frequency circuit this is not important.

The radio-frequency circuit comprises the leads to the coil A, the taps, the plate circuits of the tubes, the grid circuits and the connections to the antenna system.

It would be best to start with the two binding posts 7 and 8 and wire to the condenser K and the two opposite coils of the double choke J. Then follow the diagram in Figure 1, wiring up the other terminal of the lower choke coil J to the filament circuit of the two tubes including the two binding posts 5 and 6, and the rheostats E and F, one side of the grid-leak D and also over to the condenser B and the buzzer M. Then wire the other contact posts of the buzzer to the posts 2, 3, and 4. Then a lead should be run from the remaining terminal of the condenser B, to the top tap of the lower set of taps. This constitutes the fixed ground tap.

Now run a wire from the post 1 to the plates of the two tubes, including in series the two terminals of the ammeter L. From the plate circuit a wire should be run to the top switch lever, and its respective switch points should be wired up to the upper set of taps on the coil A.

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Then wire up the lower set of switch points to the lower set of taps on the coil A, and connect the lower switch lever over to the condenser C. The other terminal of this condenser is then connected to the remaining terminal of the grid-leak D and the grids of the two tubes H and I. Now connect up the radio-frequency choke G to the plate circuit and finish this connection to the remaining terminal of the upper winding of the audio-frequency choke J.

The last job in wiring will be to connect up the single turn of heavily insulated wire around the coil A. The two ends of this turn of wire should be connected to the two terminals of the jack N. This is the absorption loop for modulating the output of the set for telephony. The wiring is then complete.

How to Set up the Transmitter

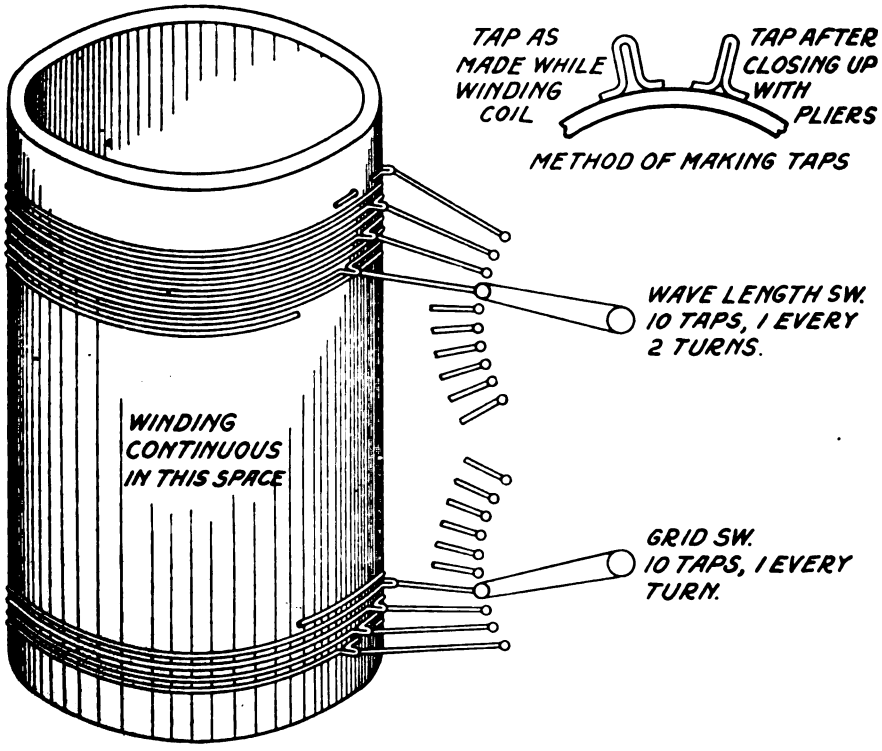
First of all, get the materials together for a short single-wire antenna and a short three-wire fan counterpoise. This will require about 500 feet of No. 12 seven-strand copper wire and 6 or 7 antenna insulators. The counterpoise should run in three directions, the middle wire should be suspended about 10 feet above ground and run straight out from the spot where the lead-in is to be located. The other two wires of the counterpoise should be placed on the same level as the middle wire and should run at an angle of about 22½ degrees on each side of the middle wire.

The antenna wire should be located as high as possible directly over the middle wire of the counterpoise. It should also point in the same direction as the middle wire. Both the antenna and the counterpoise should be about 65 feet in length. Be sure that the two lead-in wires, from the counterpoise and the antenna proper, do not run close to each other or parallel for any considerable distance.

The person setting up the antenna will have to use his own judgment in adjusting it to his own local conditions but the plan outlined above will probably be the best.

When the antenna work is completed and the proper lead-in bushings put in place, the work inside of the house can be started. Choose a place in the room that you have already picked so that the table will come right opposite the window or the lead-in bushings. This will give you short leads and added efficiency. Never run the wires to the antenna and counterpoise any distance through the house.

Set up the apparatus on the table, leave the cabinet off until the set has been in operation a few weeks and you have got it tuned to per-


TAP AS MADE WHILE WINDING COIL
TAP AFTER CLOSING UP WITH PLIERS
METHOD OF MAKING TAPS
WAVE LENGTH SW. 10 TAPS, 1 EVERY 2 TURNS.
WINDING CONTINUOUS IN THIS SPACE
GRID SW. 10 TAPS, 1 EVERY TURN.

HOW TO MAKE THE TAPPED INDUCTANCE

FIGURE 5: *The coil is wound on a composition tube as shown and the taps are made and wired to the 20 switch points on the panel.*

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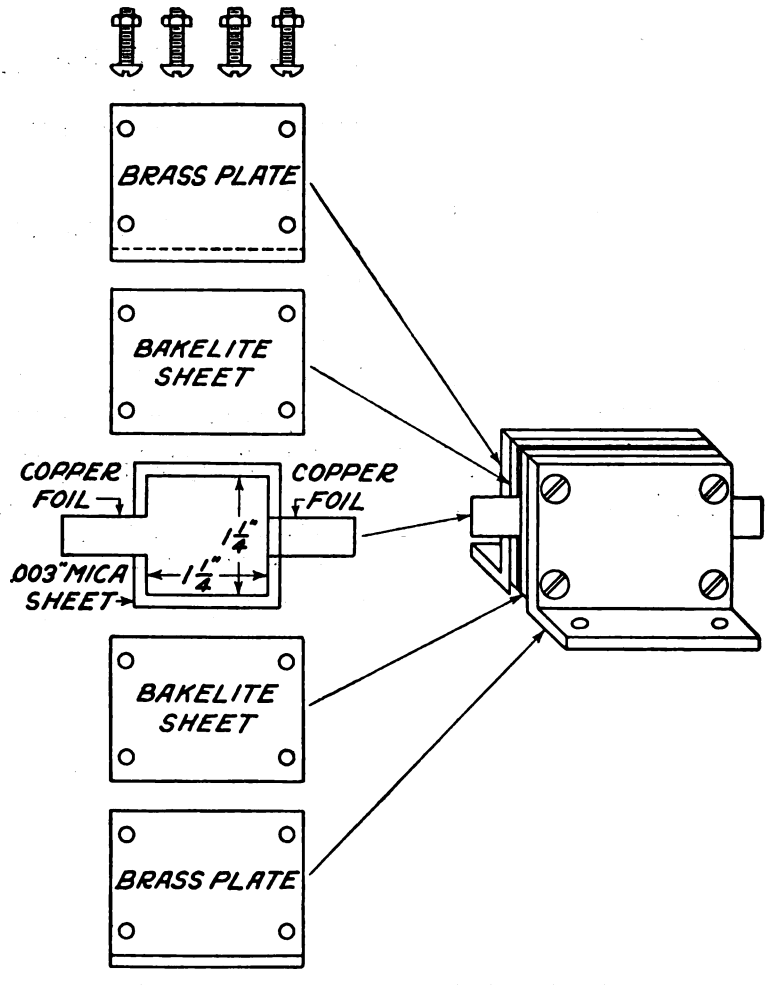

HOW TO MAKE THE MICA FIXED CONDENSERS

FIGURE 6: *These condensers can be made by any amateur who is handy with tools, but condensers of this capacity may be obtained from the dealers. If you buy them, be sure that they are for transmitting.*

fection and understand its operation better.

Connect up the starting switch on the table in a convenient position to the hand. This switch may be wired direct to the lighting circuit. Then connect the motor (of the motor-generator set) to the switch. Next, connect the positive terminal of the generator to the post 7 on the set. The negative terminal of the generator should be connected to the post 8 on the set.

Next, connect the two posts 5 and 6 to an 8-volt storage battery or an 8-volt toy transformer. If a toy transformer is used for lighting the filaments on A. C., the primary of this transformer may be connected to the starting switch of the motor generator so that the same switch can be used for starting the generator and turning on the filaments. This makes for a quick change-over.

Now connect the antenna lead-in wire to the post No. 1 and the counterpoise lead-in wire to the post No. 2. For operating the buzzer, two or three dry cells should be connected in series with a key to the posts No. 3 and No. 4.

It would be advisable to ask some neighboring amateur friend to come over to the station to help you get the set into operation for the first time. Get an amateur who has a vacuum-tube transmitter of his own. Ask him to bring over a D. C. milliammeter and insert it in the positive plate lead of the transmitter. (This is the wire running from the positive terminal of the generator to the binding post 7.) The milliammeter will tell you just how much plate current the tubes are drawing and will give a pretty good indication as to when the set is functioning properly. When the set is once tuned you can take the meter out of the circuit

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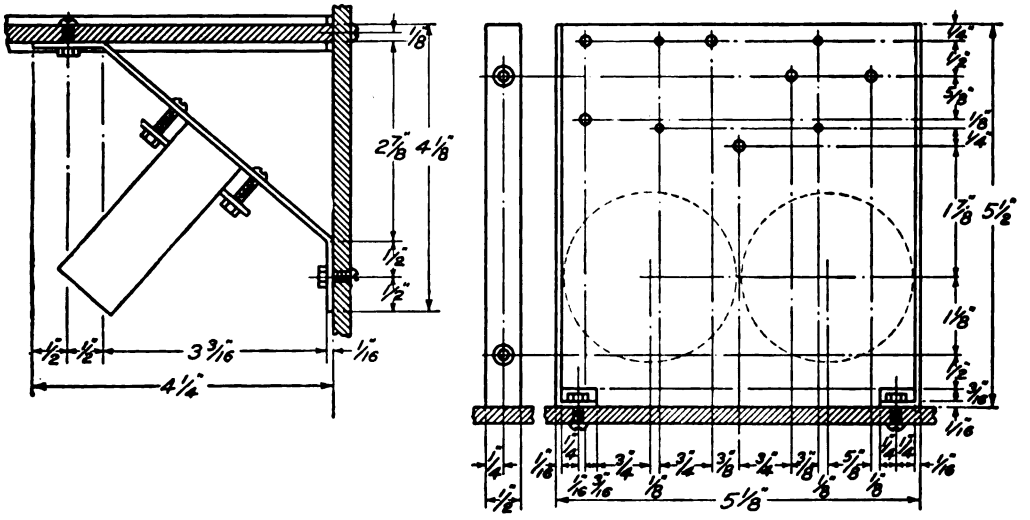
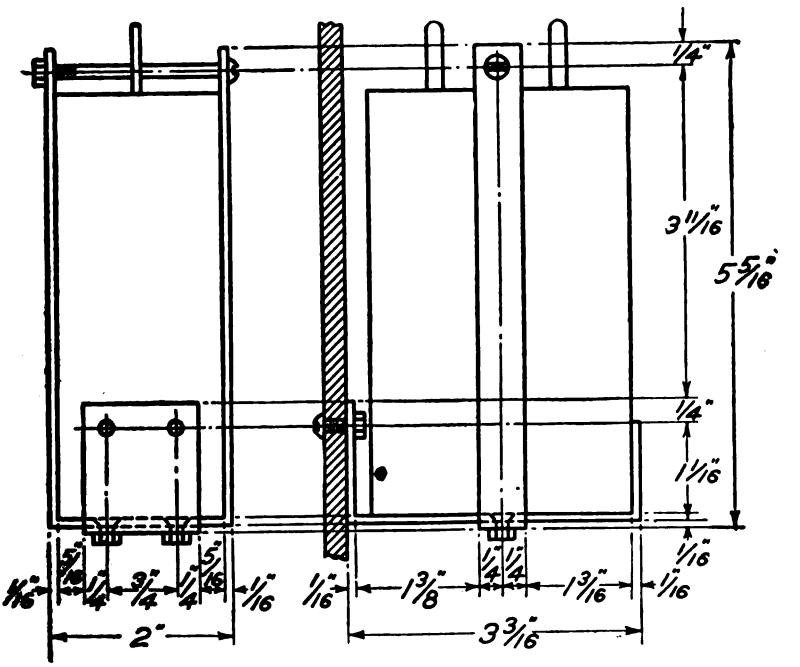


THE DIMENSIONS FOR THE SHELF AND BRACKETS

FIGURE 7: *At the left is shown the side view of the shelf with the honeycomb coil G, mounted on the slanting bracket by means of a small strip of composition and two screws and nuts. At the right is given the dimensions for the shelf and the side brackets.*



HOW TO MOUNT THE FILTER CONDENSER

FIGURE 8: *This drawing shows the end view of the condenser and bracket (at the left) and the side view after it has been attached to the panel by means of the brackets.*

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and the hot-wire ammeter will tell you if the set is working right or not.

The first thing to do in tuning up is to get the filaments of the two tubes burning at the correct brilliancy. This should be done without supplying any plate voltage to the tubes. Connect the batteries (for lighting the filaments) without connecting the generator to the supply lines. Or, if A.C. is used for lighting the filaments, disconnect the 110 volts A.C. from the input to the motor generator, so that when you close the starting switch, only the transformer will get a supply of alternating current and only the filaments will be energized. Then regulate the two rheostats, one for each tube, until you have them both burning at the correct brilliancy. The UV-202 tubes should be lighted up nearly all the way on the rheostats, but the VT-2 tubes (which are preferable in this set) should only be lighted a dull red color. If the latter tubes are lighted up brightly they will burn out!

Now adjust the top set of taps, say at the third tap from the top, and put the switch lever of the bottom set of taps on the bottom tap.

Now replace the connection to the generator and turn on both the filament current and the plate current. If all the connections have been made according to standards, the hot-wire meter should immediately begin to climb until it reads somewhere between .5 and 1.5 amperes. This is a measure of the high-frequency current being supplied to the antenna.

Now get out the wavemeter and see what the wavelength is. (By the way, this test should be made at a time of day when it will not interfere with the broadcasting, because you may exceed the allowed wavelength for a few minutes in getting the set tuned. Do *not* do it at night, when broadcasting is in full swing!)

If the wavelength is too high during this first test, keep coming down on the upper set of taps; the lower the tap you use the lower will be the wavelength upon which the set will radiate.

When you have the wavelength correct, adjust the lower set of taps so that you get the highest radiation with the smallest plate current in the borrowed milliammeter. When this is done you can take the meter out of the circuit and return it.

If you wish to use *telegraphy* on the buzzer all you need do is to press the key in the buzzer circuit. When the key is depressed the buzzer contacts will interrupt the antenna current, thus modulating it at the buzzer's frequency.

If you wish to use *telephony*, connect the microphone to a telephone plug and insert the plug in the jack on the set and speak into the microphone. The antenna current as recorded by the hot-wire meter will fall off, both when the key is depressed and when the voice is impressed on the microphone. This is a proper indication that the set is modulating.

Foto Topics, Inc.

HOW ONE PRINTER USES RADIO TO AVOID STRIKES

Overtime work in a New York printing concern caused so much difficulty in holding workmen that the manager finally hit upon the idea of installing a receiving set for the entertainment of his men while they work. Now he reports that he cannot induce them to leave the shop at all!

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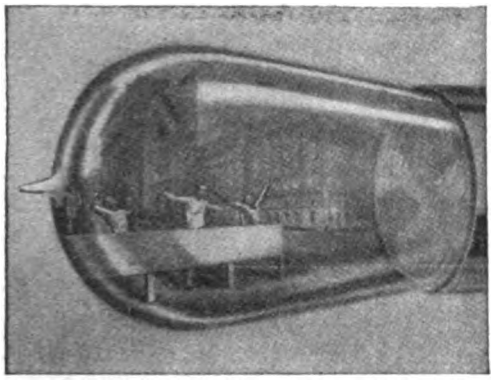
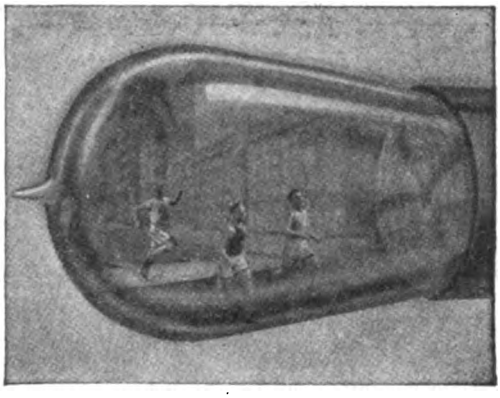


WHEN THE CHARGE IS NEGATIVE—
The vacuum tube may be likened to a one-way street in which there is a gate that is closed, when the grid of the tube is negatively electrified, blocking the roadway.



—AND WHEN IT IS POSITIVE
This gate, however, is immediately lowered when the grid is electrified with a positive charge, thus allowing the electrons (our runners) to pass through.

How the Vacuum Tube Works

ARTICLE NO. 3: THE TRIODE AS AN AMPLIFIER

This series of articles is designed to explain, in non-technical language that the layman can understand, some of the basic principles of radio phenomena

By ALFRED M. CADDELL

THE art of magnifying something small into something big so that it may be perceived better by the human senses, is a most helpful one.

Sound is magnified by ear trumpets and megaphones; vision is magnified by an arrangement of lenses that converge rays of light. With the telescope we may search out celestial bodies in the heavens; with the microscope we may search the secrets of the infinitesimal. But one of the most helpful devices in the magnifying art came into being with the invention of the three-electrode vacuum tube—the triode.

Under the heading of "detection" or "rectification" we used the analogy of heat (electrons) flowing in a one-way street*; the filament at the east end of the street radiating the heat; the cold plate symbolized as a fan drawing the heat through the street and delivering it on the outside; and the grid, or valve-gate, introduced to impress the radio-frequency oscillations of the carrier wave on the one-way current, and at the same time controlling its flow.

Then, in describing regeneration, we likened the incoming signal to a runner coming weakly into a town, bearing an all-important message.** We pictured in our mind an outpost established by the citizens of the town, a sort of extension of the town's facilities, arranged to greet the runner and furnish a stimulant to help him into the town with increased vigor. By this system of help, the runner not only received an initial but also a continuous sort of stimulant. Through the help of the local battery circuit his strength became amplified enormously, and he was able to impress

*See POPULAR RADIO for April, 1923

**See POPULAR RADIO for July, 1923

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more pointedly his message on the people (electrons) of the town.

Now we will follow the impressed message to its destination, through the highways and byways of circuits, transformers, condensers and tubes, through the phones and into the listener's ears.

No matter what else its task may be, the vacuum tube is essentially a device that magnifies received radio signals—amplification is going on continuously while the set is at work. One tube will amplify from five to thirty times according to the hook-up, while several tubes arranged in cascade will amplify hundreds and thousands of times.

The received message is magnified in the same way that a chorus magnifies the volume of a song. Then this chorus passes out of that tube (through the output circuit of the tube) into a lane (coupling circuit) to be conveyed to another town (tube), and then to another and possibly another, and so on until what was once an imperceptible little "whisper" becomes a mighty shout.

But how is the chorus output of one tube conveyed to another tube? How is it handled electrically? How is it magnified without confusion, or distortion?

First of all, the voltage of the rectified speech-current must be stepped up, for the greater the voltage introduced to the grid of the second tube, the greater will be the response. Therefore, the united chorus (the rectified output of detector tube) must pass through a step-up transformer, so that the voltage may be made higher, more decisive—a flexible trigger capable of releasing a larger source of power.

But what is a transformer? What is the principle upon which it works?

Almost everyone has what may be called the "ratio sense." That is, he knows something about gear ratios, how a large gear driving a small one, as in the case of a bicycle, results in a transmission of speeds, from low to high. If the pedal gear has 72 teeth and the wheel sprocket 9, the ratio of speed is 1 to 8—one revolution of the big gear to eight of the smaller. In stepping up the voltage of an electric current, a different arrangement is used—that of numerous turns of wire wrapped around a closed core made up of soft iron laminations. Around one section of the core is the primary winding and around the opposite section the secondary, and the ratio of step-up is according to the ratio of turns of wire. In a step-up transformer, the primary has, say 100 turns and the secondary 800. Therefore, the ratio is 1 to 8—if you had an alternating electric current with the voltage of 1 to begin with, on leaving the transformer the voltage would be 8.

But now our chorus has left the detector tube; it has been carried by the rectified current through the transformer, where the voltage is considerably increased. Now it is introduced to the grid circuit of the next tube, another one-way street through which there flows a fresh stream of electrons evaporated from the filament and drawn down the street by the suction fan (cold plate). The strengthened voltages control the flow of electrons as in the former case, and the result is a greatly magnified voice current that will now be strong enough to "work" a pair of phones, or probably a loudspeaker is desirable so that many may hear. In that case another step of amplification will be necessary to accumulate sufficient strength to overcome the resistance of the magnets of the loudspeaking device and cause the diaphragm to fluctuate.

Therefore the runner (the carrier wave bearing the incoming signal), after having his message rectified and amplified into a chorus, has at last reached the point where the message is about to be translated into a language that we can sense—sound waves.

Thus the runner goes through many modifications before the message he is

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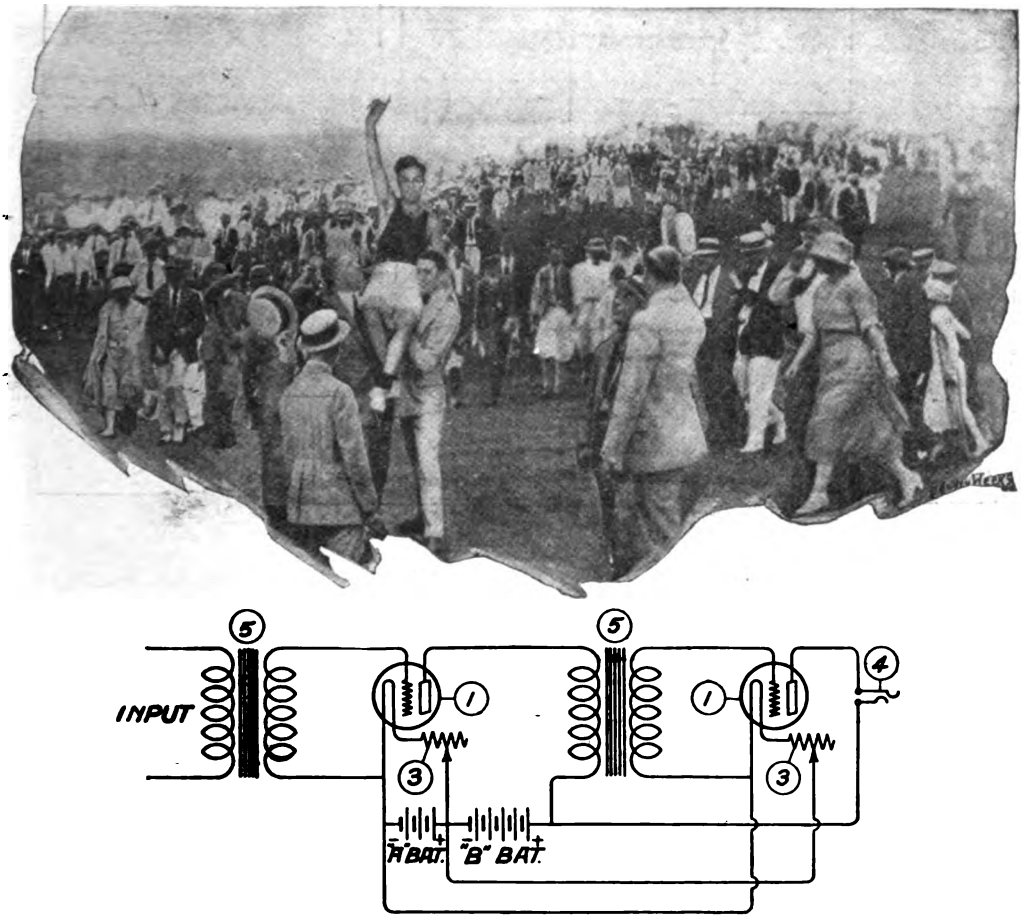

HOW THE CURRENT IN THE TUBE IS REFRESHED AND STRENGTHENED

After being strengthened by the stimulants (regeneration) given by the crowd (plate current) in the first town (detector tube), the runner (message) is carried by the crowd through a lane (transformer 5) leading to the next town (tube 1). Here he is again refreshed and strengthened and met by a larger crowd which joins in the chorus and helps him on his way to the next town. Thus the message is amplified from a feeble whisper to a mighty shout from the multitude.

carrying becomes audible. Indeed, there are many electrical highways not mentioned herein through which he might travel and receive still further amplification. For instance, radio-frequency amplification—magnifying the strength of the radio waves before rectifying, a method which embodies many good features for long-distance receiving.

So now, as our picture stands, we have a runner (incoming signal) coming weakly toward a town with a one-way street (the tube), bearing a message. Before he gets there and while passing through, he is assisted by friends (the regenerative circuit) and ushered into town through the gate-valve called the grid. Thereupon, the message he is carrying is taken up by the townfolk (the electrons) who join in the chorus and pass out of that town into a lane (the coupling circuit, transformer and other apparatus) to be conveyed to another town, and so on; so that what was once an inaudible flow of radio-frequency impulses becomes a mighty shout.

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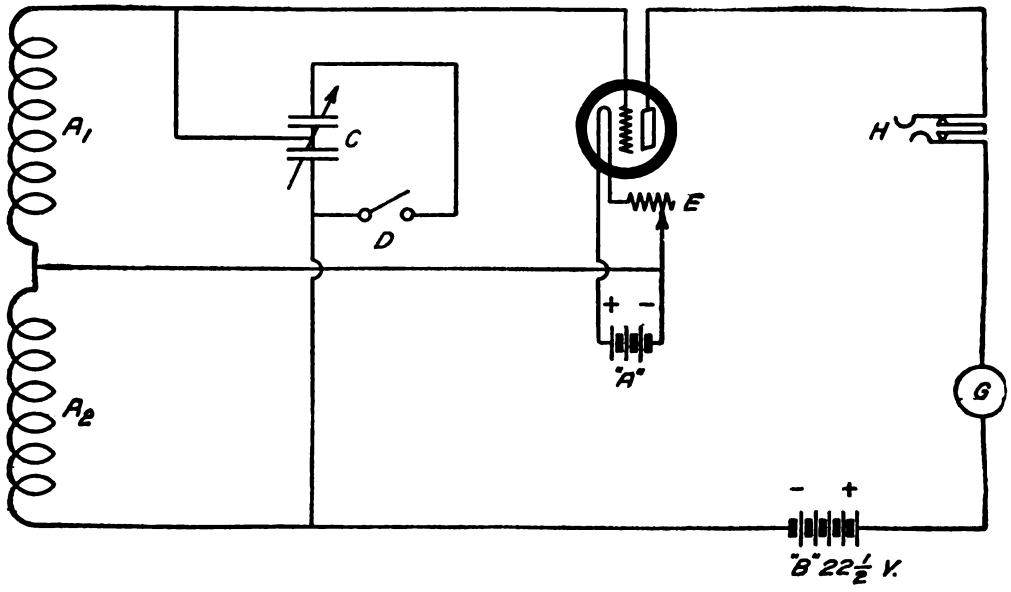

THE ELECTRICAL WIRING DIAGRAM FOR THE OSCILLATOR

FIGURE 1: *This drawing shows the proper connections for the instruments in the electrical circuit.*

HOW TO BUILD A

THREE-TUBE REFLEX RECEIVER

PART II

By WALTER A. REMY

Here is a simple vacuum-tube oscillator that can be used for heterodyne reception with *any* non-regenerative receiver. It can also be calibrated for wavelength and then can be used as a wavemeter. It is a useful piece of apparatus for any radio experimenter to own.

COST OF PARTS: *About $28.00*

HERE ARE THE ITEMS YOU WILL NEED—

A1 and A2—2 25-turn honeycomb coils;
B1 and B2—2 single-coil mountings;
C—1 balanced variable condenser. Two capacity ranges .0005 and .001 mfd.;
D—1 jack-type single-pole, single-throw filament switch;
E—1 6-ohm rheostat;
F—1 vacuum-tube socket;
G—1 D. C. milliammeter, range 0-10 milliamperes;
H—1 double-circuit telephone jack;
1 tube bezel;
1 3-inch dial;
1 2-inch rheostat dial;
1 Bakelite panel, 7 inches by 10 inches by $\frac{3}{16}$ inch;
1 Bakelite panel, 2½ inches by 3 inches by $\frac{3}{16}$ inch;
1 Bakelite panel, 1 inch by 2 inches by $\frac{3}{16}$ inch;
Brass strip for tube-shelf support (½ inch by $\frac{1}{8}$ inch).

THE heterodyne method for CW makes use of a small oscillator which is loosely coupled to the receiver. The frequency of the oscillations of the oscillator is variable.

When a signal from a CW transmitter is received it is of a frequency which cannot be heard by the human ear. The oscillator is adjusted so that it oscillates at a frequency of from 100 to 500 cycles

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lower or higher than the signal frequency. The result of these combined frequencies is the frequency difference of from 100 to 500 cycles, which can be readily heard by the human ear. This method is by far the most efficient way of receiving continuous waves.

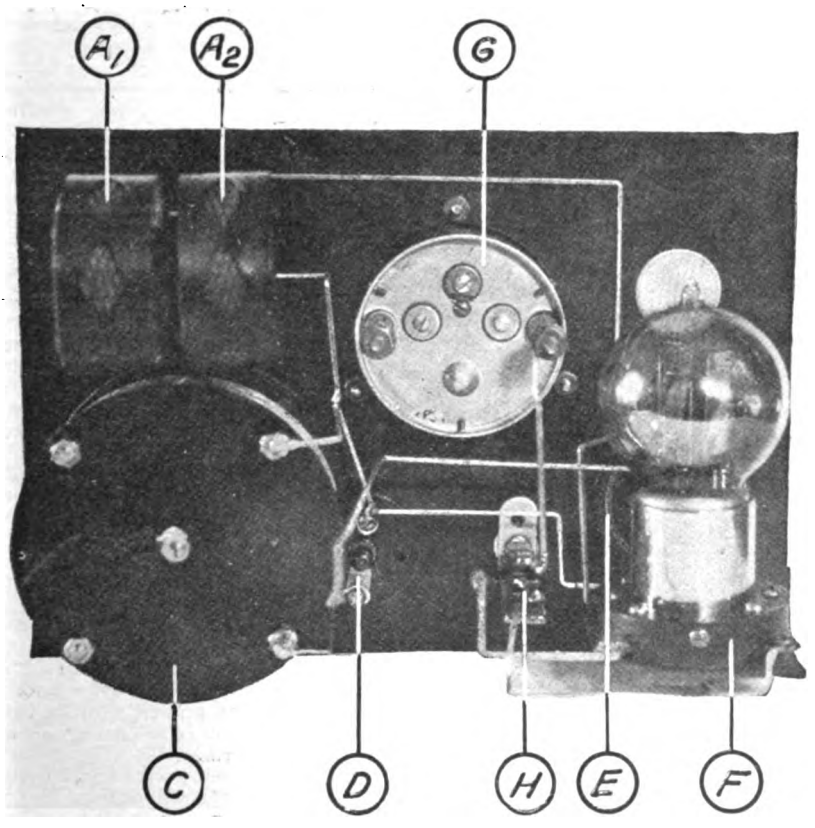
This is only one of the uses to which an oscillator such as is here described can be put. It can be used as a wavemeter, in calibrating receiving sets and in other measurements which are described in various books. It is surprising that such a useful instrument is as little known and used by amateurs today.

With the receiver described in the last article,* using Acme R-1 radio-frequency transformers and the oscillator described herein, the following amateur CW stations were heard at station 2KV during last winter: 6EN, 6KA, 6EA, 6NX, 6ZZ, 6XAD, 6ABX, 6AWT, 6BOE, 6BRS, 6BSQ, 7BH, 7NA, 7LU, 7IY, 7SC, 7ABB, 7ZO, 7ZU, 7ZV. The signals were strong and easily readable in every case.

The circuit used in the oscillator is a regular Hartley circuit in which a split inductance and a variable condenser, controlling the frequency of the oscillations, are used. The diagram of connections is shown in Figure 1.

Figure 2 shows the rear view of the completed instrument. A front view of the instrument can be seen in the illustration at the head of Part 1 of this article.

* See POPULAR RADIO for February, 1924.



VIEW OF THE OSCILLATOR FROM THE REAR

FIGURE 2: *This picture gives the arrangement of the instruments, the honeycomb coils, the variable condenser, jack, switch, meter and the rheostat and tube socket.*

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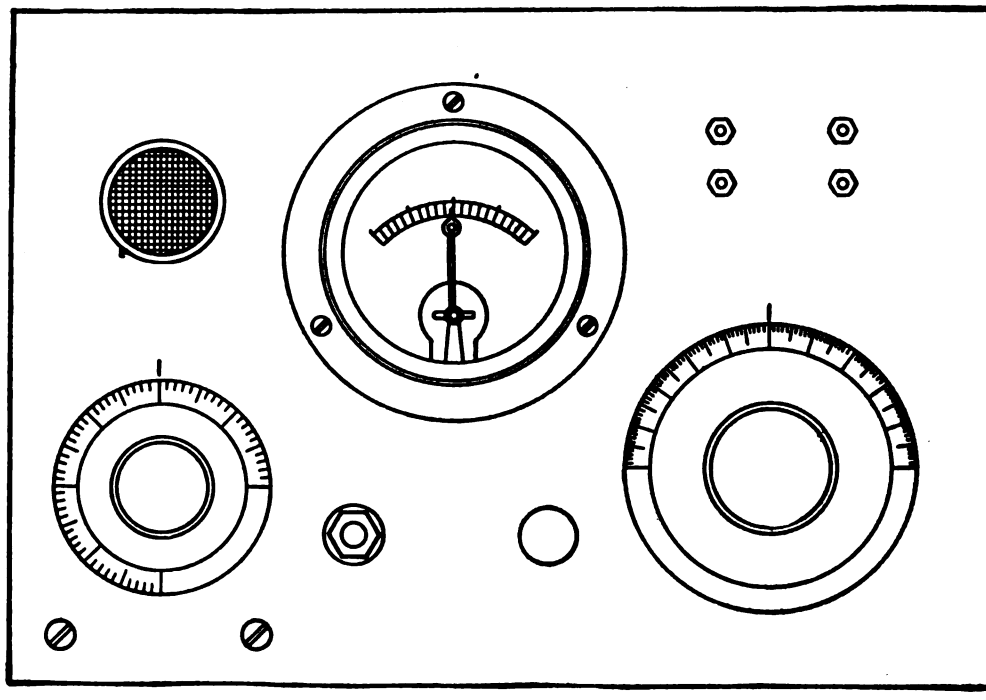

THE PANEL LAYOUT

FIGURE 3: *This drawing shows how the front of the panel looks when completed. The left-hand small dial is the rheostat control and the right-hand dial is for the variable condenser which controls the frequency of the generated oscillations.*

How to Construct the Set

In the construction of the instrument the parts specified in the head of this article are necessary and are lettered in the diagrams.

The list of parts there given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.

Practically the only construction necessary is the tube-socket shelf; the rest is merely assembling. The 2½-inch by 3-inch panel is drilled as shown in Figure 7. The two brass angle pieces are cut and drilled as are also shown in Figure 7. The unit is then assembled and the tube socket held to the sub-base with two 6/32 brass machine screws.

The panel drilling is shown in Figure 6. The large hole for the milliammeter is made with a lathe and a fly-cutter, as is the smaller one for the tube bezel. Any machine shop will do this cutting for a nominal sum. A more laborious procedure is to drill a series of holes in a circle and then cut out the circle with a keyhole saw. (The author made three holes for a CW transmitter in this manner and has never repeated the performance.) If desired, a series of small holes may be drilled in place of the bezel to view the tube. When the panel is drilled it is rubbed with emery cloth or fine sandpaper to give it a grained finish and is then polished with ordinary machine oil.

The shelf panel is fastened to the main panel by means of the two angle pieces with 8/32 flat-head machine screws. The rheostat is then mounted with 6/32 machine screws. The telephone jack and the jack-type switch are next put in place. The switch is one of the type that have recently appeared on the market for use in the filament circuits of vacuum tubes.

The condenser is mounted next. This condenser is of the double-capacity, balanced type. The plates are mounted on the rotary shaft so that an equal number of plates are on each side of the shaft, thus balancing the weight. There are two sets of stationary plates mounted in the proper relation to the rotary plates. A Broun condenser was used in the oscillator described.

The honeycomb-coil mountings should now be mounted. The regular De Forest-type mountings are not well adapted for this work because the connections are to be made between the plug and the panel. It is almost impossible to make such a connection on the De Forest-type mounting because of the two

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pieces at the top and bottom, which prevent the entire surface of the mounting from lying flat up against the panel. Two plug mountings having perfectly flat backs were used and were fastened to the panel with cap nuts. The milliammeter is next mounted on the panel.

A small 7-inch by 10-inch cabinet may be purchased at almost any radio store. The only external connections required in the oscillator are the filament-battery connections.

The small 1-inch by 2½-inch panel is drilled as shown in Figure 7 and holds two binding posts for the filament battery connections. The panel is screwed directly to the back of the cabinet after two holes have been drilled through the cabinet to allow the threaded part of the binding posts to come through. A small 22½-volt "B" battery is contained in the cabinet itself. The oscillator is now ready to be wired.

How to Wire the Oscillator

The set is wired with square tinned bus-wire from the diagram of connections in Figure 1. The only unusual part of the wiring is that of the condenser.

On the condenser there are two terminals for the stationary plates, one for each set, and one for the rotary plates. The terminal for the rotary plates is connected to the grid end of the coil mounting. One stationary plate terminal is connected to each of the switch contacts of the jack-type switch. When the plug is pushed in only one set of stationary plates is in use and the .0005 mfd. capacity is obtained. When the plug is pulled out the other set of plates is connected to the first set and the .001-mfd. capacity is obtained. Usually there is a metal strip connected across the back of the condenser connecting both sets of plates. *This connection should be removed.*

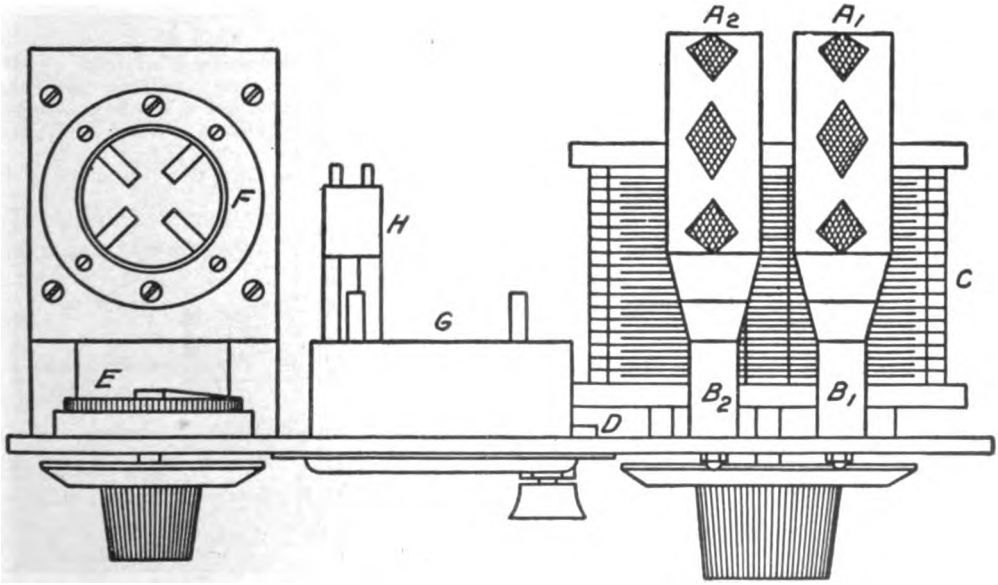
The two coil mountings are connected in series and a connection is made from the negative filament to the wire common to both mountings. It should be noted that the two inside springs on the telephone jack *are connected together* so that the current will flow when the phones are out of the circuit.

Operating Data

The oscillator is now ready for operation. The only tube which gives reliable service in this work is the oxide-coated filament type, such as the Western Electric "E" or "J" type tubes. Such tubes give a copious electron flow and oscillate readily at the high frequencies necessary in short-wave work. A UV-201 was used with fair results, although it would not work well below 200 meters.

The oscillator is set from two to four feet from the receiver and the tube is lighted. The author used the oscillator set two feet away from the receiver and at right angles to it. With an "E" tube the milliammeter should read from three to four milliamperes.

The condenser dial is then turned from the zero mark up. When the plate current drops the tube is oscillating. If the plate current *rises* the filament battery leads should be reversed. The receiver is set at a certain wavelength and the oscillator condenser is turned until a signal is heard. The receiver is then



VIEW OF THE OSCILLATOR FROM ABOVE

FIGURE 4: *A more detailed idea of the way the instruments and parts are mounted on the panel is given in this diagram. By comparing this drawing with figures 2 and 3 the prospective builder may get a complete idea of the construction.*

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adjusted until the signal is at its greatest strength. This procedure seems a bit awkward at first but soon it becomes natural to operate the receiver and oscillator at the same time. If the receiver seems to tune broadly the oscillator should be placed further away from it.

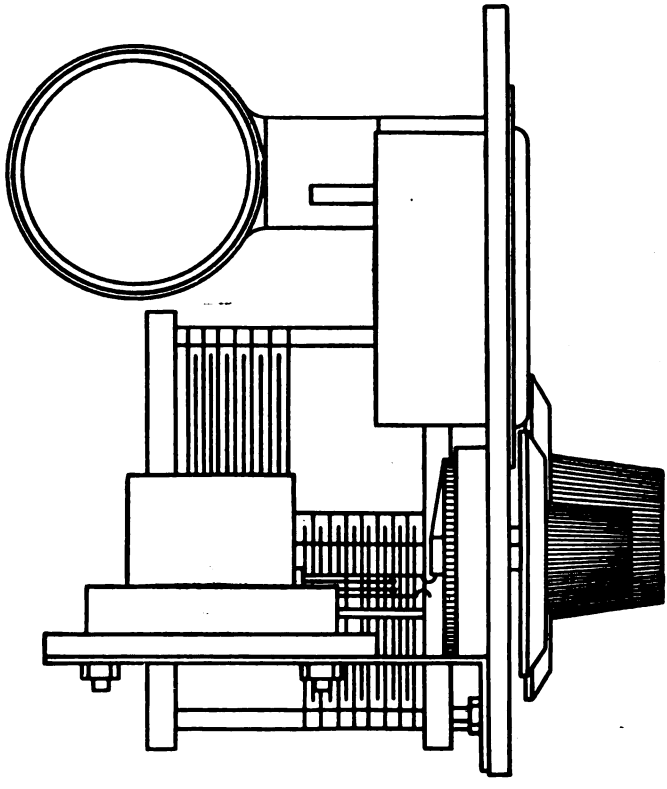
(At this point it might be well to say that it it not good practice to run the oscillator and the receiver tubes from the same "A" battery, as this somewhat destroys the tuning qualities of the receiver.)

At station 2KV the oscillator is calibrated and has a range of 175 to 300 meters with the .0005-mfd. capacity and from 200 to 400 meters with the .001-mfd. capacity. Since the frequency of 200 meter signals is 1,500,000 cycles, the 500-cycle difference in oscillator frequency makes hardly any difference between the wavelength received and the wavelength shown by the oscillator.

The true wavelength may be gotten by obtaining the zero beat. It is noted that as the dial progresses the note heard in the receivers becomes lower and then goes up again. This is due to the fact that at first the oscillator frequency is 500 cycles lower than the received frequency and that it gradually approaches the received frequency, making the frequency difference smaller and the note heard in the telephones lower. When the frequency of the oscillator is the same as that of the received signal there is no frequency difference and no sound in the telephone. Then, as the frequency of the oscillator becomes higher than the signal frequency, the note is heard again, this time rising instead of falling, as the frequency difference is increasing. That point, in between, where no sound is heard in the telephones is the zero beat and the exact frequency of the signal received.

Thus the wavelength of the station received may be determined by noting the oscillator dial reading and glancing at the calibration curve. Station 2KV will gladly give any amateur his exact wavelength.

The oscillator was calibrated by placing a standard wavemeter near it. A pair of phones were plugged into the oscillator telephone jack and the buzzer in the wavemeter was started. The oscillator was put in operation and the condenser dial set at 10-degree intervals, starting from zero. The wavemeter was then tuned until the buzzer signals were loudest in the telephones. The wavelength as shown by the wavemeter was noted and a curve plotted, using wavelength and dial degrees, respectively, as the axes.



SIDE VIEW OF THE UNIT

FIGURE 5: *This diagram shows how the socket is mounted on two brass supports which are screwed to the socket and to the panel in turn.*

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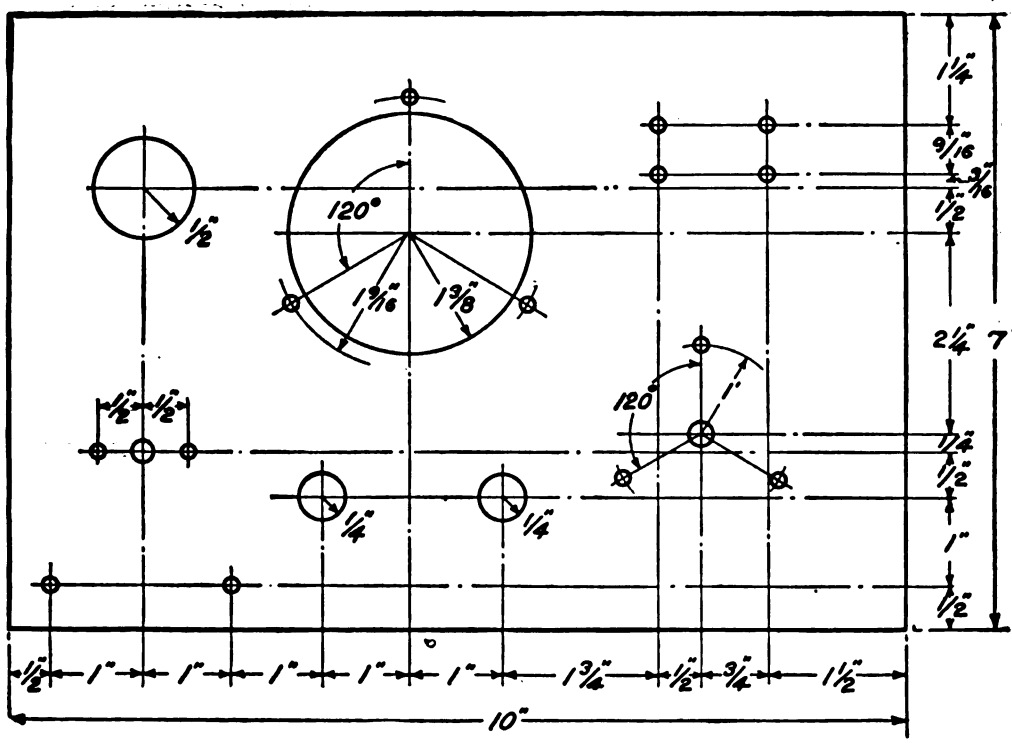
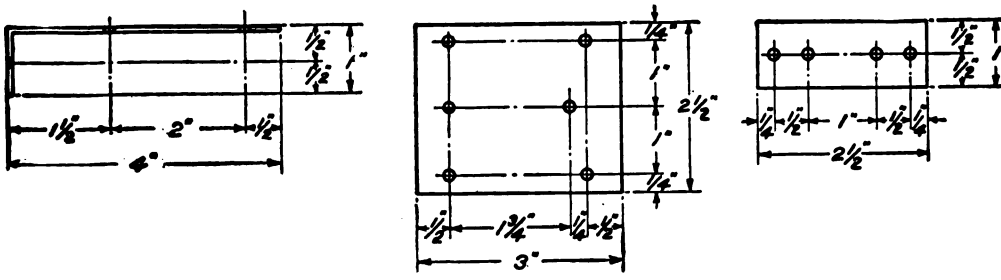


THE DIMENSIONS FOR THE PANEL

FIGURE 6: *The correct spacings for the instruments will be assured if the directions for drilling the holes for mounting them are strictly adhered to.*

When used as a wavemeter, resonance between the oscillator and the circuit of unknown frequency is indicated by an increase in the milliammeter reading or by using telephones in the jack, and obtaining the greatest signal strength in the telephones.

Such an oscillator is an exceedingly useful instrument around the amateur's station, and in conjunction with a reflex receiver it makes an ideal receiver for amateur CW work. Any frequency can be had with the oscillator by using various inductances in the coil mountings. The same number coil should be used in each mounting.



THE DETAILS FOR THE SMALLER PARTS

FIGURE 7: *The sizes for the small panel and connection block are here given, together with the dimensions for the small brass brackets.*

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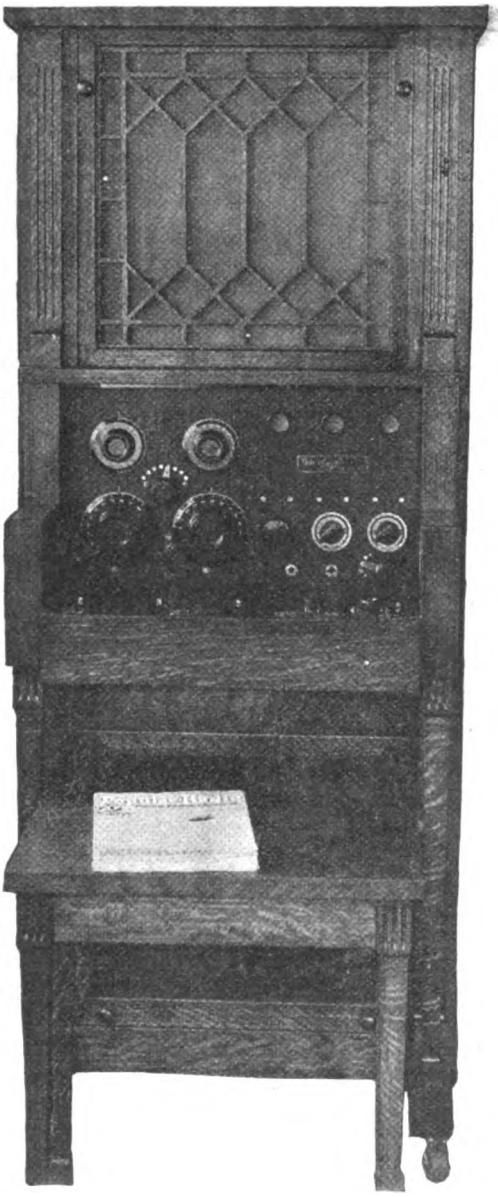

A FOUR-CIRCUIT TUNER BUILT LIKE AN ORGAN

Few readers will recognize in this imposing piece of furniture the Cockaday receiver that every fan knows merely as a small instrument that fits into a bureau drawer. It was designed and built by F. E. Davis of Syracuse, New York, who reports that the set is as efficient in operation as it is dignified in appearance. In this article Mr. Pyle points out how easy it is to give any radio receiver this same elegance of appearance so well illustrated by Mr. Davis' installation.

How to Improve the Appearance of Your Set

Now that the radio fan has got his receiver into good working order, the next step is to arrange the wires, batteries and accessories so that the set will be both convenient to operate and beautiful enough to be an ornament in the home. This article points out some of the ways in which this may be done.

By HOWARD S. PYLE, I. R. E.

WITH the acceptance of radio as a general household convenience, it is high time that we turn our attention to the general overhauling that we have promised our receiving sets for some months past.

Radio equipment has now taken a permanent place in the home, and as such should be no more intrusive or unsightly than our piano or phonograph. A casual survey of the average broadcast receiving equipment, however, will disclose the fact that about eighty percent of such instruments, while in themselves a triumph of the cabinet makers' art as well as an efficient and sensitive piece of electric equipment, are so installed in the home as to create an impression of untidiness as well as a bit of discouragement to visiting friends who, as yet, have not installed radio as part of their home life. No woman, proud of her housekeeping ability, wishes to have an unsightly storage battery, dry cells or mess of straggling wires in her comfortable living room; we cannot blame her. We know we would not tolerate a similar haphazard installation job were it to be

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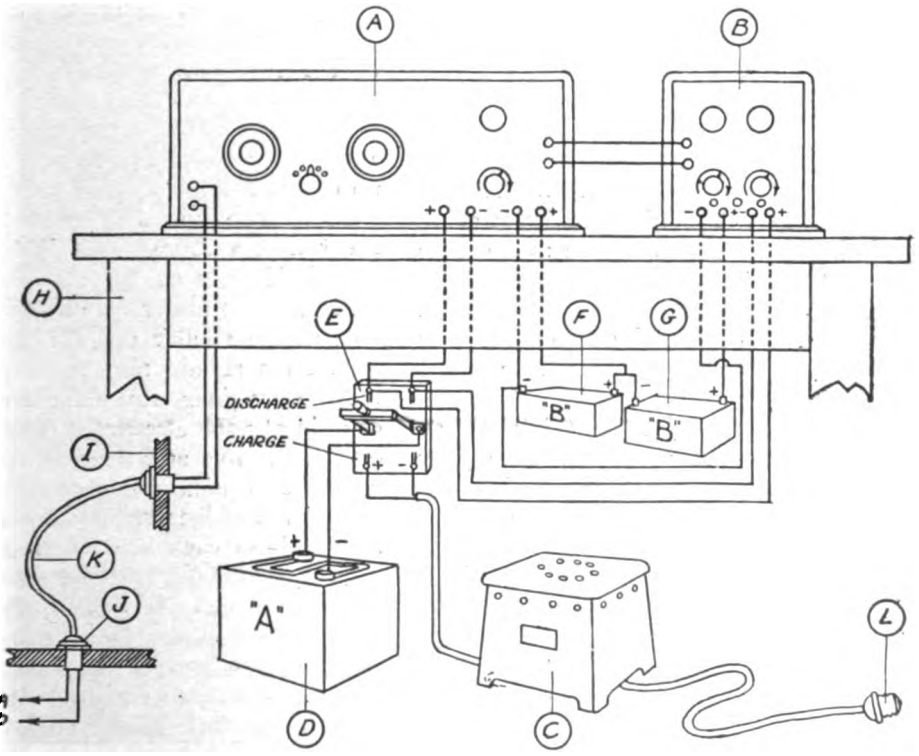
a piano lamp or wall bracket. Then why need we tolerate careless work in installing radio equipment?

A radio receiving installation offers the handyman of the house an opportunity to demonstrate his ability with the home tool chest, and offers an excellent method for spending some of the spare time that is frequently prone to drag a bit after the holiday season has passed and things have settled back into their regular routine.

Last fall and winter the main object was to get the set in and working; appearances were secondary. Radio broadcasting was completing its second year and we disliked to miss a night's entertainment. But now we have it as an established service. We are used to it, though far from tired of the diversity of entertainment to be gained through this means. Let's see if we can't make an unobtrusive appearing, harmonious piece of furniture of our equipment and then enjoy to the utmost the even higher grade of programs now available without the annoyance of loose wires and messy batteries.

Our first consideration, therefore, should be to set aside a permanent location for our receiving set, with its necessary manual controls. We should take into consideration, in deciding the location, a place which is out of the way yet easily accessible for the operator. A small table should be provided, matching the other furniture of course, and be designated *solely* as a resting place for our radio equipment. It should then be decided whether it is desirable to have the "A" and "B" batteries *with* the set, or remotely placed. If the



HOW TO HOOK UP THE RADIO TABLE

FIGURE 1: *Connections are here shown for the receiver A and the amplifier B, which are placed on top of the table, with the batteries underneath and with a plug connection for the antenna and the ground. The switch E controls the use of the battery charger C. The plug J connects the fixed wires with the flexible connector K.*

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former, the table should be provided with an enclosed set of shelves beneath the top, arranged with swinging doors at the front. Such tables are now offered in a variety of styles for radio purposes.

Perhaps such an arrangement is more desirable than a remote arrangement of the batteries. In that event, our batteries will be placed on the shelving beneath the table, with the set directly above. So far, matters are simple.

But we are now faced with the problem of connecting the batteries to the set with suitable conductors. This is where the average home installation is sadly in need of revision. Some of the tables are provided with a large opening at the rear of the lower cabinet, through which to pass the conducting wires up the back of the table to the set. This is a poor makeshift for a really good installation job. A neat wiring scheme cannot be arranged if the wires all straggle up over the back of the table to their respective binding posts. They are only in the way when the lady of the house wishes to dust, and at such times they are subject to damage or misplacement. Much as we may dislike to mar the beautiful surface of the table, it is the only way in which a good job can be made. You bought your table for radio purposes; then don't hesitate to drill holes in it where required. You dislike to think of an electrician cutting a large hole in your baseboard to install a floor plug for your vacuum cleaner, but you would not think of having him tack the wires along the baseboard to the plug. You accept the inevitable and are really surprised at the inconspicuously neat appearance of the finished plug with its plate. The same applies to your radio set.

Secure your receiving set (and amplifier if in a separate cabinet) in a permanent place on the table with good, husky wood screws. Set the instruments well toward the rear of the table and somewhat to the left of center, which will allow room to the right for future loudspeaker installation, if you have not already so equipped your set. Once you have permanently fixed the instruments, make a light pencil mark around the extremities of the base and then remove them, after marking also the approximate place over which the binding posts will be. At these latter marks, make a slight depression with a sharp center-punch (the ice-pick will do) to guide your drill. Then drill holes clear through the top, with a ⅜-inch wood bit. (You had best suggest that the good wife take herself to other parts of the house during the drilling process, for the writer knows from experience, that every twist of the cold steel into the nicely polished table top will wring a moan of agony from her.)

A hole should be made for *each* individual wire that connects the batteries to the receiving set. Ordinarily, this will mean a pair for the "A" battery, two more for the detector "B" battery and one or two, according to the hook-up of the set for the amplifier "B" battery. More will be required in the event that a loudspeaker is to be employed, if it is of the current-operated type. A hole under the antenna binding post and a similar one for the ground connection should also be drilled.

Now, on your way home from town, drop in at your electrical dealer, or even one of the five and ten-cent stores, and purchase for a few cents sufficient ⅜-inch molded-rubber socket-bushings to bush each hole in the table top. These are the little rubber bushings in use on the cap of each of the electric light sockets in your home that are not directly connected to the fixture. This is a good time also to provide yourself with sufficient silk-covered, flexible, stranded lampcord to make the necessary connections between the instruments and the batteries. Such conductor may be obtained in a variety of shades to match the flexible cord on

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Courtesy of *Radio-Électricité*, Paris

A UNIQUE SET FOR THE DRAWING ROOM

This is a French fashion hint; it is a receiver designed in Paris. The antenna is a loop, wound on the hexagonal wooden frame. The tubes are on the box below. The disk-shaped device on top of the standard looks like an electric fan but it is really the loudspeaker.

your floor lamp or to please your particular fancy.

After the evening meal, shed the uncomfortable collar, get your feet into a pair of old slippers, and we'll proceed to get down to the business of the evening.

Move the table into a good light to avoid even the slightest mistake. Smear the threaded portion of the hard-rubber bushings with a bit of the kitchen glue, and press each one firmly into its particular hole in the table top. Now the instrument cabinets may be replaced and firmly screwed fast.

Slip over and borrow the neighborhood soldering iron, if you have none of your own, and while it is heating on the kitchen gas range proceed to prepare the leads. Pass a length of the silk cord, which has previously been untwisted, down through one of the holes and cut it to a length to reach from the binding post (above the hole) to the particular terminal to which it is to be attached. It will make a neater

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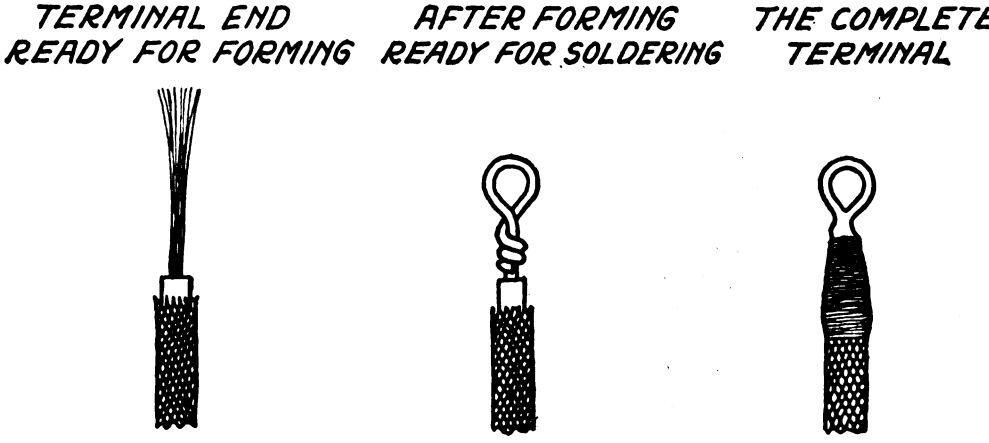
job if you will allow slack enough to enable running each wire through a system of small picture frame screw-eyes, secured at various points on the interior of the cabinet to enable leading each wire in an even, straight course with sharp right-angle bends direct to its final terminal. The insulation is then scraped from both ends of the wire, and a twisted loop made at each extremity.

Our soldering iron should be hot by now, and after applying a small bit of paste to the twisted loop of wire, we will quickly coat it with solder, making a solid closed loop. With both loops well tinned, we can finish the lead by wrapping the end, from the point where the insulation ends to that where the loop begins, with a serving of black or colored silk thread. The result is a neat appearing terminal end to the cord (see figure 2), which is electrically and mechanically perfect. This same procedure is followed with all leads. It will be found necessary to *leave* each wire in the hole while soldering the loops, for it will be found impossible to pass the finished end through the small opening in the bushing. Such an error *may* result in thoughtlessly biting a perfectly good pipe stem in two.

The loops formed as described should be of a sufficient size to enable the hole in the finished loop to fit easily over the binding post screw on the set.

We have already mentioned that the leads were to be cut to a length sufficient to reach from the set to the particular terminals within the cabinet where they were to terminate. To determine such a termination point we must consider what type of battery we contemplate using. A good many listeners still stick to the reliable, lead-plate storage cell for a filament supply source for their home set, and in the opinion of the writer, this is good judgment. Properly installed and cared for, a storage battery is less of a source of annoyance than dry cells, for if we conscientiously charge our battery periodically we are never faced with a dead "A" battery at a critical moment—usually when visitors are eager to hear a radio program. A storage-battery installation, however, is a constant nuisance if a means for charging without moving the battery is *not* provided. Accordingly, we will plan to incorporate such charging arrangement in our cabinet.

Of course, in the event that dry cells are more desirable for some reason,



HOW TO MAKE A NEAT TERMINAL FOR CONNECTING WIRES

FIGURE 2: *By proceeding in the manner illustrated above and described in this article you can make a terminal connector that will provide good electric contact, that will not slip out or come loose and that will maintain always its neat and workman-like appearance.*

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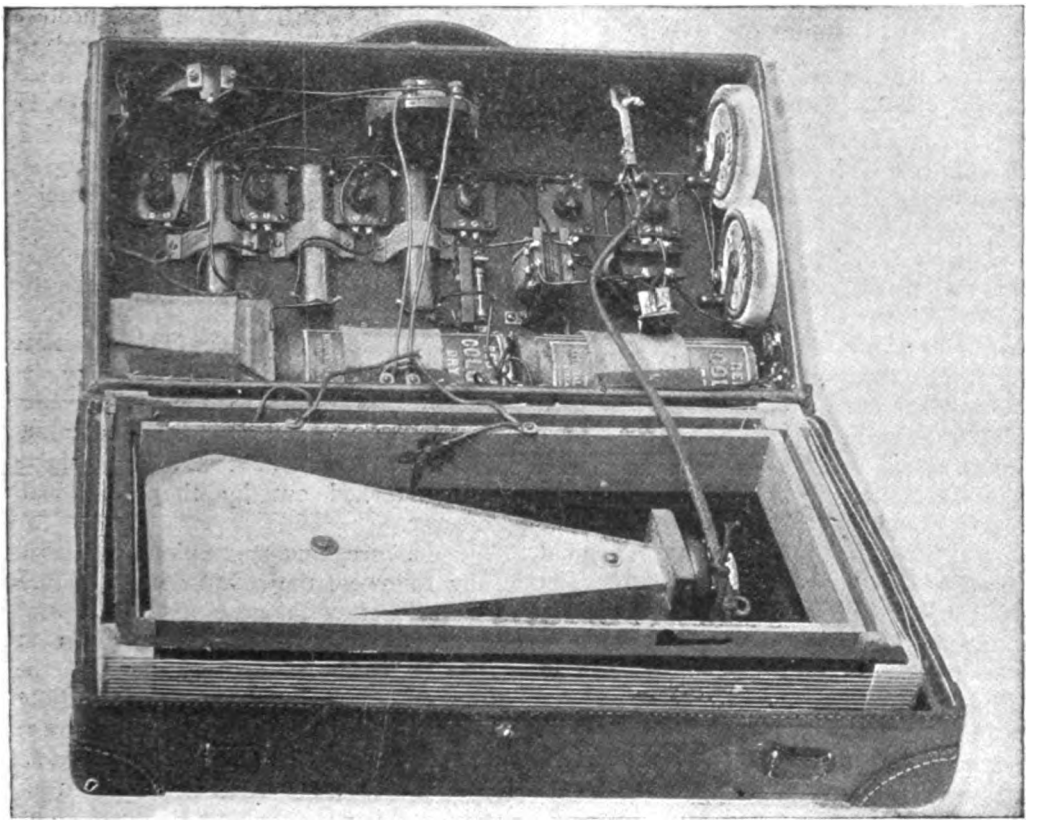

Bureau of Standards

AN EXCEPTIONALLY WORKMAN-LIKE DESIGN FOR A PORTABLE SET

This set carries out the idea of neat appearance in a set built into a suitcase. It employs three stages of radio-frequency amplification, detector and two stages of audio-frequency amplification, working on a loop antenna which may be seen on the frame in the lower section of the suitcase. The wooden horn is the loudspeaker.

the "A" battery leads are led directly to their terminals from the set. With a storage-battery installation, however, the two leads from the set should be brought to a small, double-pole, double-throw knife switch of the porcelain-base variety, mounted in a convenient place within the cabinet. The connections are clearly indicated in the diagram in Figure 1. The leads from the charging source are also brought to the opposite jaws of the switch, with the battery terminal connected to the blades. Obviously, by throwing the switch one way, we connect the battery to the set, and in the opposite direction, to the charging source. To charge, then, it is only necessary to throw the switch to the position marked *"charge"* on the diagram, and snap on the current to the charging rectifier. Similarly after completion of a charge, and when we wish to use the set, we merely throw the small switch to the opposite side and the connection to the set is complete.

The same system may be applied to the "B" battery if of the storage type, although in the case of the more commonly used dry "B" batteries the leads from the set are directly connected to their terminals as in the case of the dry-cell "A" battery.

After these connections have been made, there remain only the antenna and

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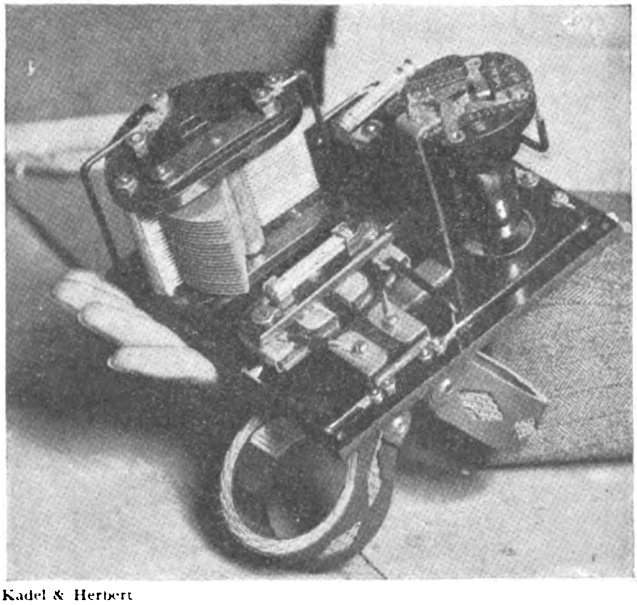
ground leads. The best method for handling these, when circumstances permit, are by means of a simple floor-plug system. The two leads from the set are brought down through the cabinet to the rear of the table, where they are connected to one of the small flush plug receptacles, known as a "telephone receptacle." This has its face plate screwed to the outside rear of the cabinet. A twisted, flexible silk cord of two conductors is connected with the detachable plug of the receptacle, and its opposite end connected with a similar plug. A second base receptacle is inserted in a hole made in the floor or baseboard, and the antenna and ground leads brought down the side of the house, through a partition to this second receptacle. This is by no means as difficult a job as it may at first appear. If the home worker shies at tackling it, however, an electrician will take care of the installation of the receptacle for a few dollars, and the finished job will be well worth the slight expenditure involved.

Do not be misled here by the over-enthusiastic radio fan, who will protest at bringing the antenna and ground to the set by means of a twisted flexible cord. The loss is negligible except in the case of a very long antenna and a long cord connecting the two plugs—thirty feet or more, when the capacity effect between the two wires does have some effect.

In the event that such a method of bringing the antenna and ground leads up to a floor receptacle is impractical for some reason, it will probably be necessary to resort to some makeshift lead-in arrangement through a window casing or like method. This will have to be worked out by the individual, however.

If the foregoing suggestions are carefully followed, the result will be a well installed set, with a maximum of convenience and a minimum of effort in daily operation. In appearance the finished job will take its place rightfully with the other furnishings of the room in which it is installed, and your radio set will no longer be a cause for constant apology.



Kadel & Herbert

A NOVEL ARRANGEMENT FOR A FLIVVER SET

This shows how Alexander Udoff, a 16-year-old experimenter, put together a Flewelling circuit for use as a portable receiver. The set employs one tube and two honeycomb coils and a variable condenser for tuning.

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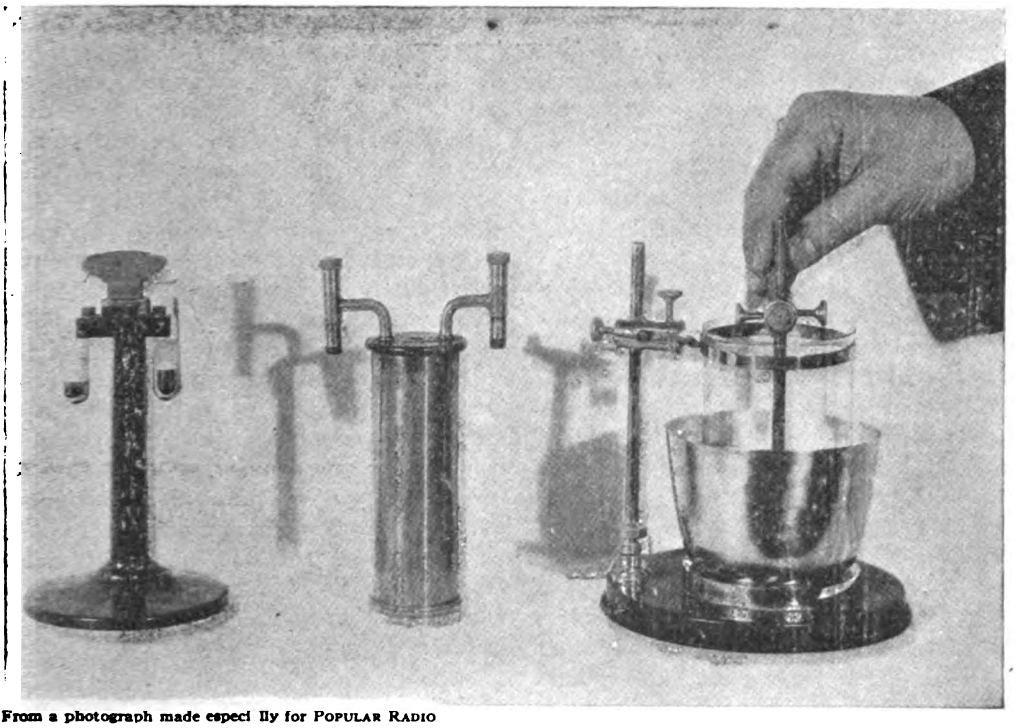

From a photograph made especi lly for POPULAR RADIO

HOW THE BUREAU OF STANDARDS MEASURES ELECTRICITY

On the left is a standard cadmium cell, the official device for comparing voltages. In the middle is a standard resistance of one ohm. On the right is the form of silver-depositing apparatus, used by the Bureau of Standards for the accurate measurements of amperage.

HOW TO MAKE

Power Calculations

ARTICLE NO. 2 OF A NEW SERIES

Useful facts about units of power and energy—summarized for your notebook

By E. E. FREE, Ph.D.

THE basis of all engineering calculations is the computation of power. Everyone who handles steam or water power or electricity must know how to transform kilowatts into horsepower, or any power unit into any other unit. Here is how to do it.

You must notice, first of all, the difference between units that mean *rate* and units that mean *amount.*

Consider a reservoir full of water. It contains a certain *amount* of water. If you open a pipe from it the water flows out at a certain *rate.* The same distinction applies, for instance, to electricity.

The kilowatt is a unit of *rate;* it means that a certain amount of electricity is flowing or being used per hour or per second. To express *amount* of

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electricity we must add to the kilowatt an indication of the time the current flowed; that is, we use the unit of the kilowatt-hour.

Similarly, the horsepower is a rate unit, the corresponding amount unit being the horsepower-hour. All figures below are in amount units.

The basic fact about all power calculations is that every kind of energy or power is convertible into heat. A kilowatt-hour of electricity may be converted into a definite quantity of heat, as is done, in fact, in an electric iron. Similarly, a horsepower-hour of steam power, or so many foot-pounds of gravitational energy, or the energy in a ton of coal or a barrel of oil, each has its definite equivalent in heat. It is as though heat were a sort of international currency into which all other currencies, like the dollar, the pound sterling, the franc or the mark, were always convertible. Only the rates of exchange between the various power units and the units of heat are not variable like the rates of exchange for money, but are always exactly the same. It is these fixed rates of exchange that are given in the accompanying table.

Suppose you have a certain amount of electricity expressed in kilowatt hours and you want to know how much heat this will produce in British thermal units:

Look for "kilowatt-hours" at the left of the table, then look along this horizontal line until you come to the column headed "British thermal units." You see the Figure 3413. This is the number of British thermal units corresponding to one kilowatt-hour. Multiply your kilowatt hours by this number and you have your answer.

Similarly, in the last line of the table you can see that one pound of coal equals 4.13 kilowatt-hours of electrical energy or (as you run your eye along the line) 5.50 horsepower-hours, or 14,000 British thermal units, and so on.

But here is a very important caution. These figures are for *perfect conversion;* for what engineers call an efficiency of 100 percent. You cannot attain this practically. For example, the best steam engines have an efficiency of less than 25 percent; that is, they convert less than a quarter of the energy of coal into energy of motion or into electricity. Accordingly, for the practical calculation of the power that you can actually get out of coal you must take, not 4.13 kilowatt-hours per pound but whatever percentage of this figure the efficiency of your particular steam plant permits you to save and convert.

If, for example, your plant efficiency is 25 percent, the real figure is 1.0325 kilowatt-hours for each pound of coal.

The units in the table and some other units of power and energy are described below:

Ampere. A unit of electric current, not of power. Amperes multiplied by volts gives you watts, which see below.

British Thermal Unit. The amount of heat necessary to warm one pound of water from a temperature of 68 degrees to 69 degrees Fahrenheit. This is the unit of heat generally used by engineers.

Calorie. The unit of heat generally used by scientists. There are several calories which must be carefully distinguished: the one used in the table is the "large calorie" or "kilogram calorie." It is the amount of heat necessary to warm one kilogram of water from 20 degrees to 21 degrees Centigrade. The "small calorie" or "gram calorie" is one-thousandth of this value. The large calorie (used here) is the same as the "mean calorie." This is also the calorie used in measuring the value of foods.

Coulomb. The quantity of electric current corresponding to one ampere flowing for one second. To convert coulombs into other units, first calculate the watts from the coulombs and volts, then use the kilowatt-hour figures in the table.

Dyne. The dyne is a scientific unit of *force,* not of power. One dyne-centimeter equals .000,000,0737 foot-pound, which see below.

Erg. A scientific unit of energy. It is the same as the dyne-centimeter, just defined.

Foot-pound. The usual engineers' unit of energy. It is the energy necessary to lift one pound one foot, or, conversely, the energy produced by a weight of one pound when it falls one foot.

Force de cheval, also called the *French horsepower* or the *metric horsepower* is used by French engineers. It equals .9863 horsepower.

Horsepower-hour. The horsepower was originally intended to represent the power that can be exerted by an average horse, but horses

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vary so much in strength that this meaning has been given up. The unit is now defined as equal to 550 foot-pounds per second. The exact value is nearer .7457 kilowatt, but the figure of .746 used in the table is the one commonly employed.

Joule. The scientific unit of work. One kilowatt-hour equals 3,600,000 joules.

Kilogram-meter. The metric unit corresponding to the foot-pound. It means the energy necessary to lift a kilogram one meter. One kilogram-meter equals 7.233 foot-pounds.

Kilowatt-hour. One watt is the power available in an electric current of one ampere flowing between potentials that differ by one volt. The practical rule is that volts multiplied by amperes gives watts. One kilowatt is one thousand watts.

Poncelet. An old French unit equalling 100 kilogram-meters per second. It equals 4/3 force de cheval, which see above.

Pound of Coal. The value of 14,000 British thermal units for the heat set free by the burning of a pound of coal is an average value for good coal. Some kinds of coal will produce as much as 16,000 British thermal units per pound; others fall as low as 11,000 or 12,000. *Wood* will produce from 7,000 to 9,000 British thermal units per pound. *Oil* yields from 18,000 to 20,000 British thermal units per pound. One barrel of oil is 42 gallons, or from 300 to 330 pounds, depending on the kind of oil.

Poundal. An old unit of force, corresponding to the dyne (see above). It equals the weight of .03212 pound.

Ton-mile. The expression is frequently misunderstood. It is *not* a unit of power or work, but of transportation. It indicates the number of tons of commodities transported, for example by railway, for an average distance of one mile. The *power* required to do this depends on many other factors such as railway grades, efficiency of locomotives and the like, and has no determinable relation to the ton-mileage.

Watt. See kilowatt, above.

Power of Men and Animals

A man will exert, on the average, about one-tenth horsepower, or .8 horsepower-hour per working day. This equals about 75 watts, or just about enough power to keep one electric lamp burning. For periods of a few seconds a man of average strength can exert as much as one-half horsepower but he cannot continue to produce energy at this rate without severe fatigue.

The average horse exerts about .6 horsepower during an eight-hour day, but can exert two horsepower or even more for a few minutes at a time. The most powerful animals in proportion to their size are the insects, some of which can exert more than a thousand times as much power, proportionately, as a man can.

Water Power Calculations

The power available in waterfalls may be calculated by multiplying the height of the fall in feet by the amount of water in pounds. This gives the power in foot-pounds. Other units can be calculated from the table. This is total theoretical power. Actual power developed depends on the efficiency of the plant, which may reach 90 percent for large, well-designed power plants. One gallon of water weighs approximately 8.3 pounds.

A TABLE OF CONVERSION FACTORS

	Kilowatt-hours	Horsepower-hours	Foot-pounds	Large calories	British thermal units	Pounds of coal
Kilowatt-hours	1	1.340	2,660,000	860	3413	.244
Horsepower-hours	.746	1	1,980,000	642	2547	.1818
Foot-pounds	.000,000,377	.000,000,505	1	.000324	.001286	.000,000,0918
Large calories	.001162	.00156	3085	1	3.968	.0002832
British thermal units	.000293	.000393	777.5	.252	1	.000,0714
Pounds of coal	4.103	5.50	10,885,000	3528	11,000	1

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THE COMING

World Language

Will the international code developed by radio lead to an international method of communication between peoples who speak different tongues? Some scientists think it will. In the light of this possibility, the radio amateur becomes a figure of wide significance.

By EDWIN E. SLOSSON, Ph.D.

THE premature attempt to construct a skyscraper in Babylon some five thousand years ago was stopped by the curse of the confusion of tongues. When the mason at the top of the tower yelled down "More mort!"—meaning by that a bucket of bitumen—the hod carrier was as likely as not to tote up to him a tale of adobe bricks. This caused hard feelings and harsh language.

The curse of the confusion of tongues has rested upon the world ever since. It is getting worse of late. The World War brought to birth a dozen nationalities, which are now struggling to survive the diseases of infancy. These new nations are bursting with patriotism. Their self-respect demands that their vernacular shall be placed on a parity with the leading languages of the world. Every country is ambitious to attain economic and cultural independence and is striving for it by tariff walls, postal impediments, embargoes and boycotts. Nationalism is the order of the day. Secession and separation are in the air. The new map of Europe looks like a patchwork crazy-quilt. The map-maker can hardly muster up enough different colors to keep the countries distinct.

But while statesmen are breaking up the world into smaller portions, scientists are bringing the world together. Paint up the map into as many patches as you please but it is impossible to put up partitions in the ether. Wireless waves know no nationality. They spread in all directions equally and nothing can keep them out. The frontier may be lined with custom house officers, censors and soldiers, but the radio waves will pass right through them. Anybody anywhere may listen in without the consent or knowledge of the sender. Walls and mountains, rivers and seas, do not prevent the passage of the ether messages.

There is only one factor that acts as a barrier. This is difference of language.

The curse of Babel rests upon the radio. What though the telephone of the

From a photograph made for POPULAR RADIO

"THE RADIO FAN IS BECOMING A WORLD POWER"

So states Dr. Slosson, one of the most widely known writers on scientific subjects in America.

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Eiffel Tower in Paris can reach all Europe and North Africa if the peoples within hearing talk thirty diverse languages?

As long as most people lived all their lives in one place it did not matter if every valley spoke a divergent tongue. As long as intercommunication was confined to print, mail and telegraph it was possible to get along with the aid of interpreters. But when millions are receiving messages without intermediaries they must have a common language.

A year ago it was an open question whether we ever could or would have a common language. Today it is not a question of could or would. It is a matter of must.

We've got to.

The only question now is what the international language shall be. And how we shall get it?

Already, under the pressure of necessity, various international languages are growing up. The commercial and maritime codes of the world comprise a larger vocabulary than many historic tongues. Music and mathematics have a common symbolism the world over. The names and formulas of the sciences are much the same in all languages. Possibly these separate and spontaneous movements may grow eventually into some sort of a world-language but it would be a haphazard and unsatisfactory affair.

Five hundred years ago Europe had an international language. Latin was spoken and read by the learned classes of all lands. Some professors now propose to revive Latin as the common language of commerce, diplomacy and science.

It would seem sensible to adopt some living language. But which? If we should put it to a popular vote Chinese would win by a large plurality. But who can learn the Chinese alphabet? It hasn't any. Shall the world be asked to accept Russian with its unpronouncable consonants, German with its unspeakable grammar, English with its illogical spelling or French with its elusive idioms? Mutual jealousy will probably prevent the people of the earth from agreeing to adopt any of the existing tongues as a medium of international communication.

Finally, there are several languages invented for the express purpose, nice tidy tongues; no exceptions to the rules, no irregular verbs; pronounced as spelled and spelled as pronounced; said to be easy to learn but not enough people are learning them. Here, too, there is rivalry. Esperanto is now in the lead but Ido claims to be an improvement on it.

In some way or other the world will soon acquire a common medium of communication. The more numerous the languages the more need for another that all peoples shall know. So the forces of nationalism will themselves force internationalism. And it is not inconceivable that the International Code signals, which are coming into more general use as the knowledge and practice of radio spreads, may be a determining factor in deciding what the world-language will some day be.

The radio fan is becoming a world power.

How to Build a Simplified Neutrodyne Receiver

In the coming issue of Popular Radio—*for April—will appear a complete, detailed description of a non-regenerative radio-frequency set that is, in effect, a modified form of the popular neutrodyne receiver, but which is of extraordinary efficiency. This new set has been developed by the technical staff of* Popular Radio, *and constitutes what is perhaps the most valuable contribution of the year to the equipment of the radio fan.*

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HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Warning Investors by Radio

A NEW use is being found for radio —for the protection of investors and to the confusion of crooks in the financial world. This plan was originated in Cleveland by the Union Trust Company and the Cleveland Better Business Commission, using the Union Trust Company radio station WJAX to broadcast descriptions of typical fake stock schemes and the like which the Commission knew were current in Cleveland and vicinity. Here is a special report of the scheme, made for POPULAR RADIO:

A few weeks ago the Better Business Commission learned that high-pressure salesmen of questionable brokerage houses were trying to sell stocks over the telephone. They would call up one after another of the people on their "sucker list," represent themselves to be investment bankers and give their prospect an "inside tip" on a "hot stock" that was going "to take a rise of from 8 to 10 points any minute." They would talk easy profits and partial payments and, of course, if the prospect seemed at all interested, they would follow up the telephone conversation with an actual sale.

The danger in this lay, of course, in the fact that the "investment houses" which these salesmen represented were not reputable houses and any investor who bought through them stood in imminent danger of losing all his money through failure of the "investment house." In fact, only a few months ago one of these houses did fail and people who had bought stocks on these telephone tips lost everything which they invested.

After obtaining accurate information about this method of stock solicitation from the Better Business Commission, station WJAX broadcast a complete description of this method. Prospective investors-to-be were warned of the high-pressure telephone salesmen. The radio story urged, "before you invest, investigate," and suggested that people get in touch with their bank or the Commission in regard to any proposed investment.

This same method was followed up in order to warn Clevelanders against fake "help wanted" ads. A certain company advertised that men were wanted for bench work—but when they applied for jobs, they were told they would have to buy stock in the company before they would be employed. Some men went ahead and bought stock in order to get jobs. At the end of two weeks, the men were discharged and when they asked the president of the company to buy back their stock as he had agreed to do, he merely laughed at them. Of course, the whole thing was just a "blind" to get money away from unsuspecting workmen. Station WJAX broadcast the full description of this scheme and warned the public against it.

Another "stunt" against which investors were warned by radio was that of the fellow who called upon stockholders in a certain company and told them a long and involved story about New York manipulations which would shortly increase the value of their stock enormously, urging them to buy more stock as soon as possible and suggesting that they give him the money or Liberty bonds with which to make the additional purchase. Of course, the whole thing was faked and the operator was simply after the Liberty bonds or other sound investments of the "suckers" on whom he was calling.

Many letters and inquiries have been received by the Cleveland Better Business Commission as a result of this broadcasting and the success of the plan has been such that its adoption is now being considered by the New York Better Business Commission.

The Union Trust Company and the Cleveland Better Business Commission will continue this plan of warning investors throughout 1924. These warnings will be broadcast every Thursday evening from WJAX, and whenever possible, they will give the public notice of fake investment schemes now being attempted or typical of those being operated currently within Cleveland and vicinity.

—D. S. KNOWLTON

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What to Do When Your Set Goes Wrong

WHEN, for no apparent reason, your set quit working the other evening did you hold your temper and test the set out carefully? What you *should* do is told by a reader in Conway, Arkansas:

Look at your antenna carefully and inspect your ground and lead-in. Possibly your antenna has become grounded or your ground or lead-in has either been broken or become loose.

Then look at your "B" battery; sometimes it takes a sudden drop in voltage and, therefore, the tubes do not work right.

Next examine your tubes; once in a while the soldered connections on the prongs become corroded and form a high resistance path for the current; this is equivalent to a bad connection. This may be remedied by rubbing them on a piece of sandpaper until the solder shows up bright.

Next inspect the phone cords. It may be that the tinsel is broken and that you need a new cord. To test them, turn on your tubes, put on your phones and carefully "feel" the cord an inch at a time, bending it back and forth. If there is no sudden increase in the signal strength the cord is O. K.

Then examine all the flexible connections of the set, such as the pigtails of the condensers and the coupler. Blow out all the dust that has collected in between the plates of the condenser. If everything seems all right, carefully inspect the set, looking for crossed leads and corroded connections.

It stands to reason that if the set worked all right just before and that if you did nothing to it, that it is only some minor trouble which usually may be found outside the cabinet.

—GUY SIMMONS, JR.

A Vaseline-carbon Grid-leak

THIS Los Angeles fan has devised an improved grid-leak that may be useful to other radio constructors. He passes on his idea as follows:

I have found a fact that may help some of the fans who have trouble with the "pencil type" of grid-leak. I marked heavily on a piece of cardboard with a lead pencil and placed it across the terminals of my grid condenser. I got no result. Then I smeared a little vaseline on the cardboard and fastened it to the condenser by bending it over and clamping it to the two terminals with a paper clip. To my joy it worked.

Next, I ground up some carbon from an old dry-cell and mixed a little of it with some more vaseline. I then took the plain vaseline off and smeared some of the vaseline-carbon mixture on the cardboard. It made my set 100 percent louder.

—HUGH J. HAMILTON

International

RADIO MAY BE USED TO SCORE RIFLE HITS

Recent tests by the Signal Corps, U. S. A., have indicated that wired wireless and radio systems are more satisfactory and cheaper than ordinary telephones for communicating the number and place of hits from the targets of a rifle range to the officer in charge of the shooting.

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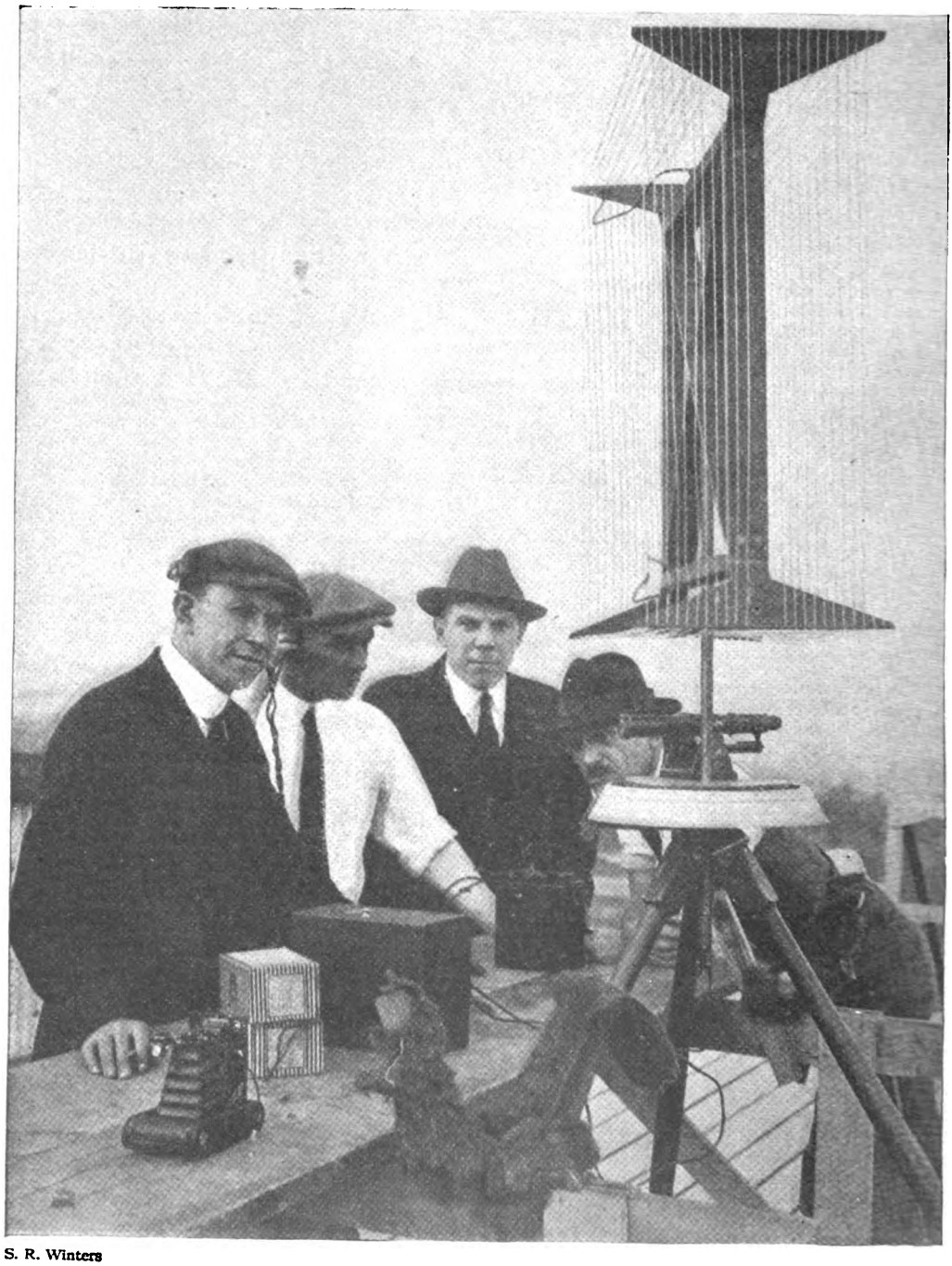

S. R. Winters

A DIRECTIONAL LOOP ANTENNA FOR PRECISION MEASUREMENTS

This loop is used as a part of the radio-compass installation at the airship hangar at Lakehurst, New Jersey, where the great dirigible, SHENANDOAH, *is stationed. The telescope permits the comparison of the radio direction with the line of sight.*

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Are Deserts a Source of Static?

A RECENT item in POPULAR RADIO about the prevalence of static disturbances in the neighborhood of the mountains of northern Mexico has brought in many letters from radio observers in that neighborhood. Not only the mountains but the deserts in this part of the world seem to be great offenders. Here, for example, is one fan who has found the Imperial Valley, which is in the heart of the great Colorado Desert, to be a point of origin for much disturbance:

I am an ex-operator, who was once stationed at San Diego, California, and have had considerable experience in receiving in Mexico, California and vicinity.

My experiences with static in this region are as follows:

It is directional, or very nearly so, and invariably seems to originate in the Imperial Valley.

It is both blanket and crashing and the crashing is sometimes terrific.

From 7:00 A.M. to perhaps 6:00 P.M., it is at a minimum in intensity, though the signal strength also seems to be at a minimum at this time. Starting about 8:00 P.M. and on until midnight the static gains in volume and is at a maximum from midnight until 4:00 or 5:00 A.M. Then it gradually decreases and is *nil* at 7:00 A.M.

July, August and September are the worst months. The hotter the Imperial Valley temperature the more crashing static there is.

It is generally, though not always, more intense on the long waves, that is, on 4,000 to 20,000 meters.

Reception is often very difficult during the day because of weak signals and at night because of static interference. Reception in southern California is usually better from the east than from the west.

Finally, though static is severe and may cause difficult receiving conditions, it can be minimized and practically eliminated with a barrage system of receiving.

—H. J. WILSON

How the Radio Compass Is Tested for Use on Airship

TESTS have been recently conducted by D. H. Shallcross, radio-compass engineer, to ascertain the amount of deviation (if any) that is caused by the huge hangar upon the interception of radio signals by a direction finder when the dirigible *Shenandoah* is approaching this building. The findings of these preliminary tests justify the conclusion of the radio-compass engineers of the Bureau of Engineering that remarkably satisfactory results may be expected in the operation of a loop antenna in connection with other radio receiving apparatus when in the immediate vicinity of, or located on, a metallic structure of the nature of the Lakehurst hangar.

The radio direction finder employed in these experiments is approximately 36 inches square; together with the tripod upon which it is mounted, it weighs about 35 pounds. This weight, however, is subject to variation, depending upon the auxiliary apparatus that is carried along to make a variety of investigations relative to the influence of metallic objects upon electromagnetic wave fronts. Mounted on the base of the loop, which is distinguished for its sharp directional characteristics, is a telescope which enables the operator to make visual as well as radio observations. These observations with respect to the radio transmitting station enable observers to ascertain the amount of *deviation* which provides necessary data to prepare a chart or deviation curve, thereby computing the distortion produced upon electromagnetic waves by large masses of metal or other energy-absorbing objects.

The equipment used in studying the wave phenomena on the hangar at Lakehurst has heretofore been applied in original investigations of the United States Navy Department in radio-compass stations on shore or on a man-of-war. That is to say, a major portion of the original data relative to electromagnetic wave variations and deviations caused by the different media over which these electric waves have to travel is afforded by the portable direction finder. It is an invaluable instrument in studying the distortion of electric wave fronts as well as in determining the source or station from which these particular waves emanate.

—S. R. WINTERS

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QUESTION: I have been experimenting with honeycomb-type inductance for the last six months, changing from one hook-up to the other and trying to find out how many different ways they may be used. I have been trying them with your four-circuit idea and have had some very favorable results. Do you know of any other variations of the four-circuit principle that would be interesting for me to try as an experiment? I get more fun out of the actual experimenting than in the broadcast programs.

Can you give me a hook-up using the idea of an isolated circuit arrangement so that I could use a triple-coil mounting and a double-coil mounting? I want to try something more along these lines as I find that the more circuits the signals have to pass through, the sharper the tuning becomes.

SIDNEY G. CORY

ANSWER: The circuit shown in Figure 1 should interest you. You will need the following parts to try it out:

L1, L2, L3, and L5—honeycomb or duolateral coils, size L-35;
L4—Honeycomb or duolateral coil, size L-50;
VC1—variable condenser, .001 mfd.;
VC2 and VC3—vernier variable condenser, .0005 mfd.;
GL—variable grid-leak;
GC—mica grid-condenser, .00025 mfd.;
R—filament rheostat (to suit tube used);
C—mica fixed condenser, .0005 mfd.;
Tel—telephones;
"A" and "B" batteries.

Coils L1 and L2 may be placed in the double-coil mounting, and coils L3, L4, and L5 may be placed in the triple-coil mounting. The two coil mountings should be placed at right angles to each other.

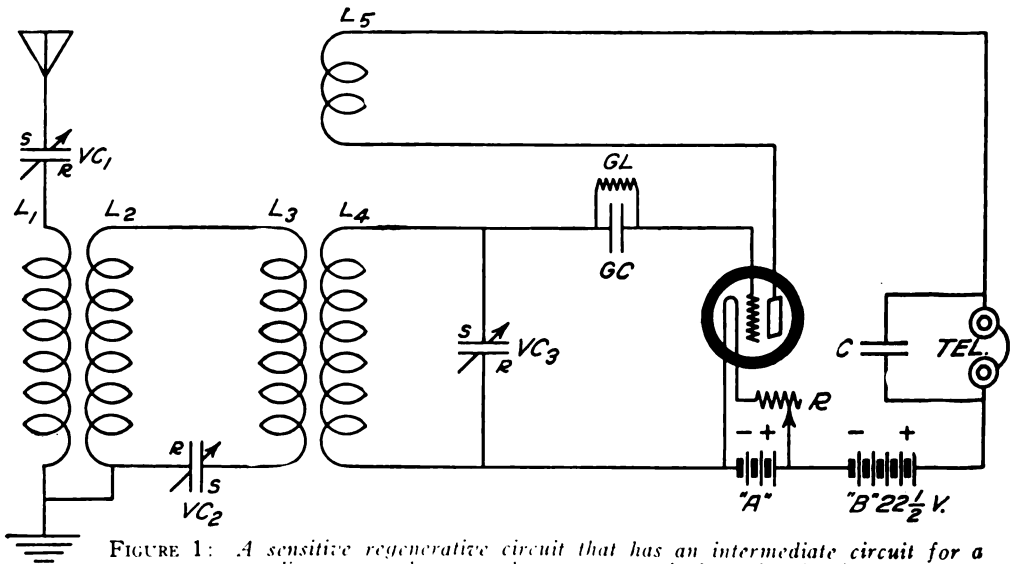

FIGURE 1: *A sensitive regenerative circuit that has an intermediate circuit for a coupling means between the antenna and the grid circuit.*

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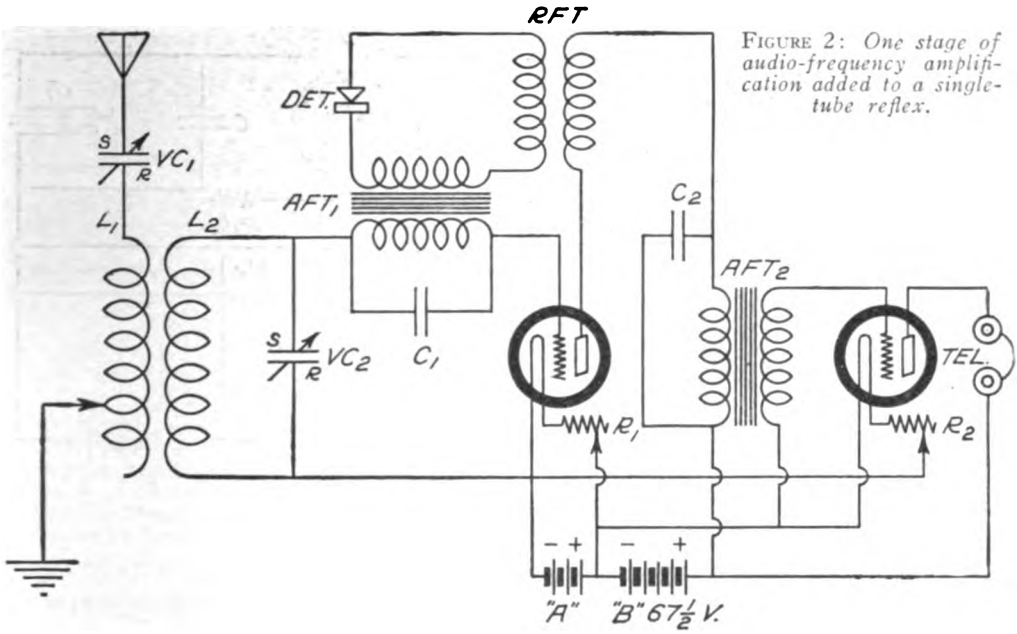

FIGURE 2: *One stage of audio-frequency amplification added to a single-tube reflex.*

QUESTION: I am sending you a diagram of my single-tube reflex set that has a crystal detector. It is giving me perfect results. It brings in the signals with great clarity and I enjoy it very much. I have just obtained a loud-speaker and I find that the signals are not quite loud enough for practical results. The signals can be heard from the horn when everything in the room is quiet but if anyone walks around I miss what is being played or sung. What I would like to do is to add one stage of audio to the reflex if it is possible. Can it be done? If so I would appreciate it if you would let me have it through the magazine. I notice that you say you will help out your readers with their problems.

JOHN HOWARD

ANSWER: The circuit diagram for the additional stage of amplification added to your present set is shown in Figure 2. The parts that you will have to get to do this are the following:

AFT2—audio-frequency amplifying transformer;
R2—filament rheostat;
C2—mica fixed condenser, .001 mfd.

* * *

QUESTION: How far above the roof do I have to string my single-wire antenna? There are now two antennas on my roof, one on each side of the house running parallel with each other. The landlord wants us to put up all our antennas on one side of the roof so that the other side of the roof will be clear for washlines, etc. I do not think that this would be so good and therefore am sending you this question. What would be the best way to run mine and what kind of support would you suggest using?

ANDREW WALLACE

ANSWER: You will have less interference from your neighbors and cause them less interference while tuning, if you run your proposed antenna at right angles to the other two. The easiest and most convenient way to string it up is to use a 16-foot "2x4" pole set up alongside of the clothesline supports and guyed with wire, so that it will remain taut and upright when the antenna strain is put upon it.

* * *

QUESTION: How many volts should be used on the C-300 vacuum-tube detector plate? K. J. L.

ANSWER: Use a tapped "B" battery of 22½-volts maximum. You will find the best operation when the plate voltage is somewhere between 16 and 18 volts. Try moving the clip on the "B" battery when listening in to a DX station until you get the loudest signals. There will not be much difference on local signals.

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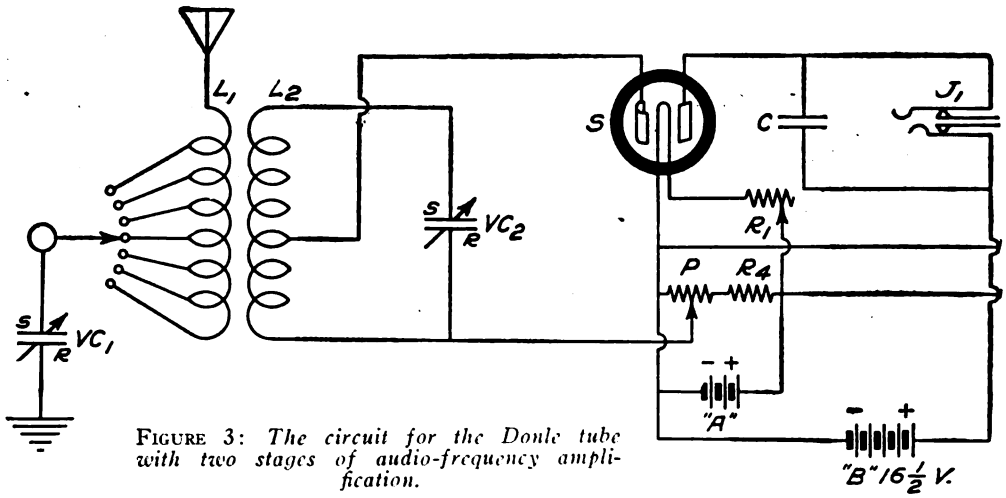

FIGURE 3: *The circuit for the Donle tube with two stages of audio-frequency amplification.*

QUESTION: Is the Donle tube and the sodion tube one and the same thing? I happened to be at the first disclosure of this new tube (the Donle) and I think I remember that he was connected with the same company that has just brought out the sodion. I was astonished at the time at the great sensitivity of this new form of tube and now I want to know if this is the perfected tube and if so, can you give me a circuit to use it with. I would also like to use two UV-199 tubes with it as audio-frequency amplifiers. Will you give me the circuit if my suppositions are correct?

CLEMENT BLANDI

ANSWER: They are the same. In Figure 3 you will find the wiring scheme for this tube together with two stages of audio-frequency amplification. You will need the following parts:

L1 and L2—variocoupler;
VC1—variable condenser, .001 mfd.;
VC2—variable condenser, .0005 mfd.;
P—potentiometer, 100 to 200 ohms;
R4—resistance unit, 100 ohms;
R1, R2 and R3—rheostats, 20 ohms;
C—mica fixed condenser, .0005 mfd.;
AFT1 and AFT2—audio-frequency amplifying transformer;
S—sodion tube;
2 UV-199 tubes;
J1 and J2—double-circuit jacks;
J3—single-circuit jack.

The secondary of the variocoupler should be tapped at about ten turns from the bottom for the collector terminal of the tube.

* * *

QUESTION: Will the small vacuum tubes that operate on dry cells give as good results on an audio-frequency amplifier as the ordinary storage-battery tubes?

AUSTIN KELSEY

ANSWER: These small tubes, dry-cell tubes they are commonly called, will not give as great amplification at an audio frequency as the regular (storage-battery) tubes. They have their own particular advantages, however, for portable sets, or for uses where there are no charging facilities for storage batteries.

For instance, the over-all cost of a single stage of amplification in a receiving set, including batteries, is much less than half for the dry-cell set than for the storage-battery set and the efficiency from a current-amplification standpoint is about seventy-five percent of that of the storage-battery set. If two stages of audio-frequency amplification are used, the efficiency would only be about fifty-five percent. The more stages used, then, the greater the difference in efficiency.

This means, that taken from a standpoint of both efficiency and cost, the dry-cell tube set compares favorably if only one stage of amplification is used, but for more stages it is advisable to use storage-battery equipment.

The dry-cell tubes are about equal in radio-frequency work, as the amounts of energy present in this form of amplification are well within the power limits of such tubes.

* * *

QUESTION: I accidentally allowed the two wires running to my storage battery to touch, and they got almost red-hot before I could get a stick to push them apart with. I also burned my hand on the hot wire, but I do not mind that if the battery is unharmed. How can I tell whether or not the battery is damaged?

T. H. S.

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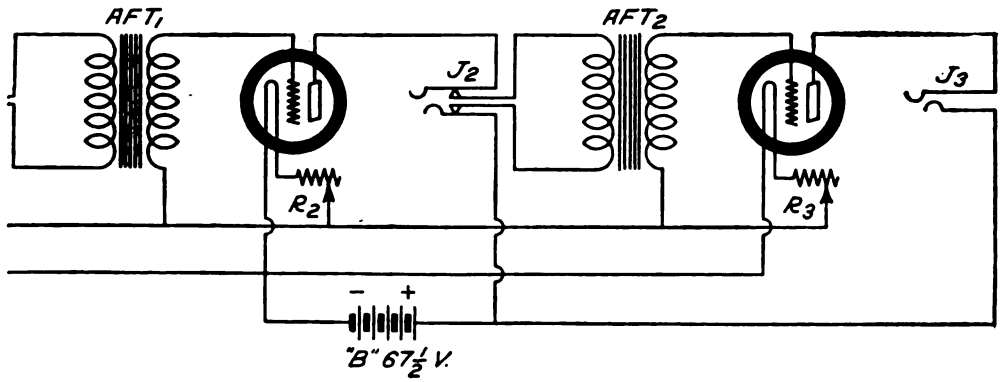

ANSWER: You can tell whether or not the battery was damaged by connecting it up to your set. If the tubes light all right, the battery is still in good condition. If they do not light up bright enough, the battery will need recharging.

If the recharge does not help them to recuperate, you probably left the short circuit on too long and the overload caused the battery itself to heat up and the plates to buckle. In this event you will need new plates; a new battery would be more economical.

In connecting or disconnecting batteries always remember to do it in the following way:

In connecting up: Connect the wires to the instruments *first*, then connect the wires to the batteries.

In disconnecting: Disconnect the wires from the batteries *first*, then disconnect the wires from the instruments.

In this way you *cannot* have any short circuits at the batteries and the batteries *cannot* be damaged.

* * *

QUESTION: Which should I use, the water pipe or the steam radiator for the ground on my receiving set? I can make the ground to the radiator with a lead of only a few feet, but will have to run about 20 feet to the water pipe. Which should I use?

HOWARD CUSHING

ANSWER: Use the water pipe. It will probably be better even if you have to use a longer length of wire to reach it.

* * *

QUESTION: Which is the best, a gas soldering iron or an electric one?

D. S. ADAMS

ANSWER: The electric soldering iron is much more convenient for the experimenter. He can leave it turned on while he tries some experiment, without fear of it overheating and oxidizing. In other words it is always on the job and needs no watching.

QUESTION: What voltage should be used on the filaments of the WD-12 tubes? I have had my set put away while I have been traveling and I have forgotten whether I used one or two dry batteries with it. I am afraid I might burn out the tube if I "monkey" with the batteries and try to find out myself.

J. F. T.

ANSWER: The tube you mention requires a voltage of 1½ volts on the filaments. One dry cell will be correct.

* * *

QUESTION: Can one rheostat be used successfully for controlling the filament current for the two tubes in a push-and-pull audio-frequency amplifier? If so, please let me know the proper rheostat to use with 201-a tubes.

H. M.

ANSWER: One rheostat can be used, provided that the two tubes are identical. (The two tubes should be identical for successful operation.) The proper resistance rheostat to use with the tubes mentioned is one of 20 ohms resistance.

* * *

QUESTION: What is a suitable length for a single-wire antenna for listening in to the broadcasting?

JOS. H. RENWICK

ANSWER: A single wire with a horizontal length of about 100 feet.

* * *

QUESTION: What voltage should be used on the plate of a "soft" detector tube in the single-tube Reinartz?

MILTON ROSS

ANSWER: Use from 16 to 18½ volts.

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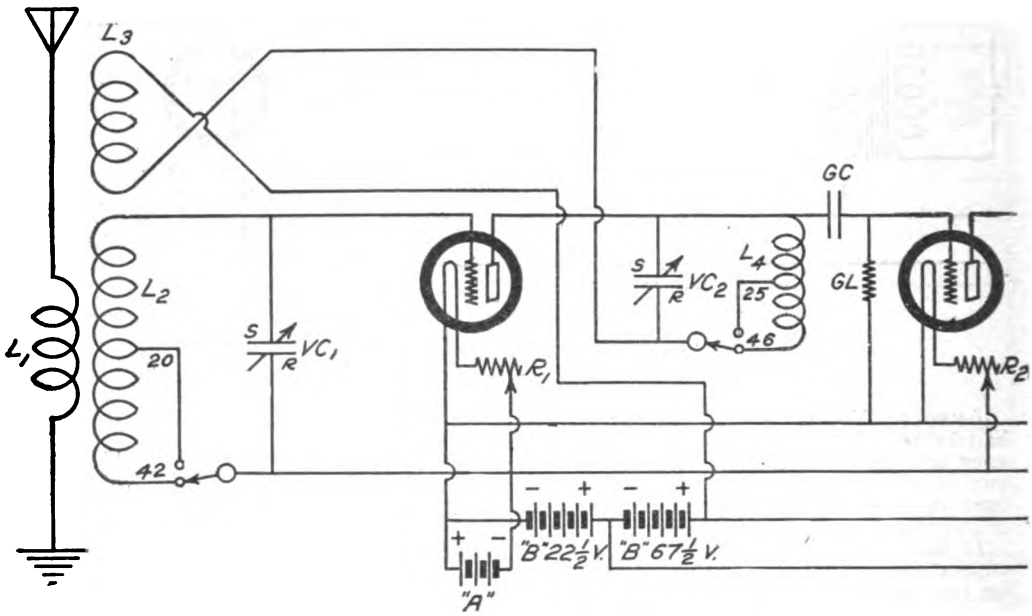

QUESTION: Will you please give me the circuit for the superdyne as recently brought out by C. D. Tuska? Is this circuit anything like the neutrodyne? I would also like to have the constants for the various instruments and the data for the coils. Do you think that a set containing the features above mentioned would be too difficult for an experimenter to work out and build for his own use?

HENRY F. DRUMMOND

ANSWER: The circuit you require is shown in Figure 4. This circuit accomplishes the same thing as the neutrodyne, but by a different method. In the neutrodyne, feedback is eliminated by means of the neutralization of the tube capacity. This constitutes, in theory, the use of a capacity bridge in which a small condenser is used to balance or neutralize the capacity between the grid and plate electrodes of the tube.

In the superdyne the elimination of feedback is accomplished by a reversed voltage which is also fed back to the grid circuit, but in this case it is done inductively. The system uses a *reversed* tickler coil.

The parts you will need for the set are the following:

L1, L2 and L3—the special coupler;
VC1 and VC2—variable condenser, .0005 mfd.;
L4—plate inductance coil;
GC—mica fixed condenser, .00025 mfd.;
GL—variable grid-leak;
R1, R2, R3 and R4—filament rheostats (to suit tubes used);
AFT1 and AFT2—audio-frequency amplifying transformers;
two switch levers;
four switch points;
J1 and J2—double-circuit jacks;
J3—single-circuit jack.

For coil L2, wind, on a composition tube 4 inches in diameter, 42 turns of No. 22 DSC copper wire, with a tap at the 20th turn. The winding L1 consists of 4 turns of the same kind of wire wound over the secondary winding. Coil winding L3 consists of 36 turns of the same wire wound on a rotor, 3⅝ inches in diameter. The rotor is inserted halfway into one end of the 4-inch tube and arranged with bearings and a knob so that it may be rotated.

There is nothing extremely difficult in making such a set and any radio fan will experience a lot of pleasure and learn a lot of the theory of radio in building one. The set will function satisfactorily when constructed and operated properly.

* * *

QUESTION: Would it be possible for me to make the "audio" amplifying transformers for my receiver? I want to try to make all the parts for my set if there is no special apparatus or knowledge required to do so. If you think I could do the job satisfactorily please give me a complete description of the way to do it.

WALTER C. HOOP

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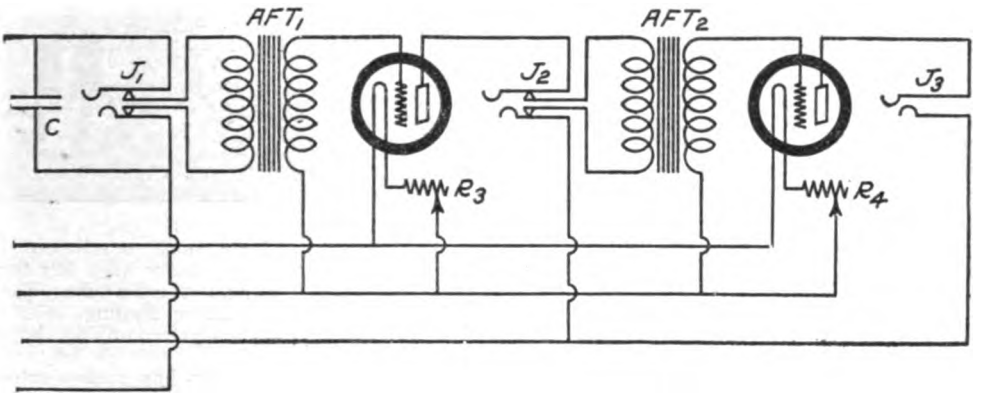
FIGURE 4: *The superdyne circuit which accomplishes, by electromagnetic means, what the neutrodyne does, by electrostatic means. This circuit tunes sharply and is very sensitive to DX signals.*



ANSWER: There is too much detail and too many obscure but essential points of construction (not to mention the physical qualities of the materials necessary) involved in the manufacture of transformers for audio-frequency amplification for the average amateur or radio fan to be able to make even a fair job in building his own transformers. This is true of most of the parts used in built-up sets. The progressive man who "rolls his own," in the way of radio sets, does not attempt to make the individual parts; he buys instruments and apparatus that he knows are good, and then assembles them into a set employing the particular hook-up that he is interested in, at the time. In this way, if the hook-up is trustworthy and if his wiring is done correctly, he gets good results.

However, if he makes the parts himself he soon finds through experience, that he cannot do as good a job, or as economical a one, as the manufacturer. In the first place, he finds that when he gets a part completed, after spending a lot of time doing it, that it doesn't give the results he expected, and in the second place, he is astonished to find that it *costs more* than the manufactured parts.

Our advice is to stick to reliable, standard manufactured parts which have proven their worth by wide usage. In this way you will avoid the disappointed feeling that comes from a combination of careful planning (seemingly), hard work, but at the same time *poor* results.

* * *

QUESTION: What does the R and S, which is printed on all of your wiring diagrams next to the symbols for the variable condenser, stand for? I am unfamiliar with these markings and wish to make a set that has these markings on all of the variables.

E. MARK WAITE

ANSWER: The R stands for the rotary elements of the condenser and the S stands for the stationary plates. When shown in a diagram with these designations, the connections should be made to the stator or rotor terminals as specified. This will assure the builder of a set which, when completed, will not be sensitive to "body capacity."

* * *

QUESTION: Can radio be used to communicate with the spirit world? It seems to me that if radio waves cannot be seen or felt, and have no body and no sound, that they would be of the same stuff as spirits are made of and could be used to communicate, back and forth, with spirits. Has there ever been any experimental work done along these lines?

K. F. ENGLE

ANSWER: We refer you to the article "Ghosts That Talk—by Radio" by Houdini, in the October, 1922, issue and the article "Can We Talk to the Dead by Radio?" by Carrington in the June, 1922, issue of POPULAR RADIO. These will give you two views on the subject that should help you to form your own opinion.

* * *

QUESTION: How many feet of No. 18 DSC copper wire will I need to make the new four-circuit coils?

A. C. HENDRICKS

ANSWER: You will need approximately 120 feet of it.

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A Detector Tube Filled with Liquid Silver

In the past few months there have been several announcements of the possibility of radio detection by means of what are called "colloidal solutions" instead of by the ordinary methods. The matter has been put to careful test by Mr. Joseph Roussel, Secretary of the French Society for the Study of Radio.*

Let us see, first, just what a "colloidal" solution is. It was noticed many years ago by the English chemist, Graham, that there exist in nature two different kinds of solution; one of them transparent and perfectly fluid, like a solution of salt or sugar, the other more or less cloudy and viscous, like a solution of glue or of white of egg. These cloudy, glue-like solutions Graham called colloids.

In recent years there has been a great deal of scientific work done with such solutions—so much so that colloid chemistry is now a recognized branch of science. It has been found that the real characteristic of such solutions, the thing that sets them apart from the ordinary transparent solutions like those of sugar or salt, is that the colloidal solutions contain a lot of very tiny, invisible particles that are not dissolved at all. It is possible, for example, to make a colloidal solution of metallic silver, and this solution contains, it is found, many millions of tiny solid particles of the metal floating around in the solution just as dust motes float around in the air.

Of course, these tiny silver particles are far too small for us to see them individually, but they can be detected by many scientific methods, including some electrical ones. It is these electrical properties of the floating colloidal particles that have been made use of in radio detection.

The ordinary vacuum tube operates by means of the loose electrons that escape from the filament and fly around inside the tube. As these electrons are repelled or attracted by the grid, the number of them that reach the plate changes and the plate current fluctuates. Now a colloidal solution (say, for example, a solution of colloidal silver) behaves in many ways like the electron-filled space inside a vacuum tube. The tiny solid particles of silver floating in the solution correspond to the electrons flying about in the tube.

Suppose, then, that we dip into such a solution of colloidal silver the three electrodes of a vacuum tube. The electrode corresponding to the filament need not be heated to emit electrons. We need no electrons. Instead of them we are going to use the floating silver particles. So, the filament electrode is merely one side of the filament-plate circuit. If there is a potential on this circuit, as in the ordinary tube, the particles of silver will be driven across in a stream from filament to plate, just as the electrons are driven in the ordinary vacuum tube. The grid, too, will behave just as it does in the tube. Potential changes on it will decrease or increase the stream of moving silver particles just as such changes on the tube grid affect the stream of electrons. Even with the grid omitted such an arrangement will work as a detector in the same manner as does a two-electrode vacuum tube. Using a solution of colloidal sulphur and two platinum plates for electrodes Mr. Roussel was able to receive the signals from the Eiffel Tower about twice as intensely as with the best galena detectors.

There is no probability, of course, that these new colloidal detectors will threaten in the least the supremacy of the vacuum tube, but there may be special uses for them and they are worth study by experimenters who have the requisite knowledge of colloidal chemistry or are willing to acquire it. Special uses of importance and even of monetary value might be developed for them.

If you want to try them, this is how to do it. You can buy in a drug store two preparations of colloidal silver that are suitable. One is called protargol, the other collargol.

Take a thoroughly clean glass vessel like a drinking tumbler, or better still a chemist's beaker, and fill it about half full of the purest distilled water. To this add about half a teaspoonful of a ten-percent solution of either one of the silver preparations. Dip into the solution so prepared two small platinum plates attached to platinum wires. This gives you a

*"Concerning the Colloids," by Joseph Roussel. *Radio-Électricité*, vol. 4, pages 319-324 (August 15, 1923).

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two-electrode detector. If you want to add a grid, a piece of platinum-wire net will serve. You can use silver instead of platinum if the silver is pure. Silver coins will not do.

The silver solution will spoil in a few hours and must be made up afresh, but it is possible to keep it indefinitely if the water and all materials are pure and if the whole is sealed away from the air inside a glass bulb. It is possible that sufficient experimentation with such a sealed-in solution might give us a new type of detector more permanent than a crystal and even more effective. Some radio fan who happens also to be a colloid chemist ought to try to work it out.

Dust in the Earth's Attic

AMONG the most mysterious regions on the earth is one that we look through every time we look up at the stars. It is the upper part of the earth's atmosphere, 100 or 200 miles above the ground, the region famous among radio fans as the location of that mysterious something called the Heaviside Layer.*

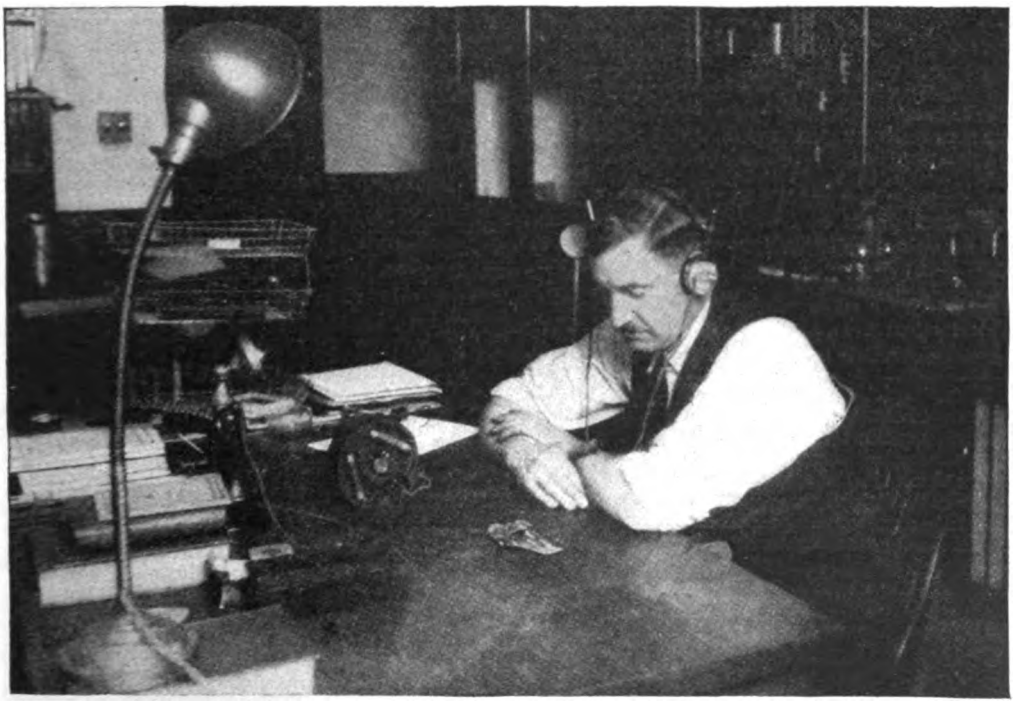
Nobody knows just what the Heaviside Layer really is. It may be ionized gas like the gas inside a Crookes vacuum tube. It may be a vast swarm of electrons. The latest idea is that it consists of dust. The earth's attic is dusty.

But the dust that exists up there is not ordinary dust. It is, the theory says, nitrogen dust. The nitrogen gas of the air is congealed by the intense cold of space into a layer of tiny solid crystals like minute snowflakes. These float in the air, or rather in space, for there is really no air there except as these nitrogen dust particles represent it. This is the theory recently formulated by Professor Vegard of the University of Christiania.*

If we could be sure that this is right it would be of great importance to radio. A full understanding of the principles of radio transmission is unlikely to be attained until we know just what the Heaviside Layer really is and just what are its electrical and magnetic properties. The problems of fading are presumably related to this. So are the many peculiarities of distance radio like the fact that the five-watt transmission of an American amateur has been heard clearly in New Zealand,

*The theory of the Heaviside Layer has been discussed in POPULAR RADIO by Sir Oliver Lodge, Dr. Elihu Thompson, Major General George O. Squier, Dr. R. A. Fessenden and others. See Dr. Fessenden's article in the issue for November, 1923.

*L. Vegard. "The Constitution of the Upper Strata of the Atmosphere." *Philosophical Magazine*, vol. 46, pages, 577-604 (October, 1923).



Keystone View Co.

LISTENING TO THE "TALK" OF INSECTS WITH RADIO APPARATUS

The Thomas glow-transmitter, described in POPULAR RADIO *for July, 1923, is so sensitive that it picks up sounds even above the usual range of audibility. Some insects make such sounds; sounds that are too shrill to be heard by unaided human ears. Dr. Thomas is shown listening to the sounds made by a moth.*

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far beyond the range indicated by any existing theory. Few branches of general science are more important to radio, both theoretically and practically, than is the science of the upper air.

The new nitrogen-dust theory of Professor Vegard was reached by the study of the light of the aurora, especially the analysis of this light in a spectroscope. Another line of attack has been followed out in England by Professor F. A. Lindemann and Mr. C. M. Dobson.* They have been studying the streaks of light produced by shooting stars, and they conclude, quite differently from Professor Vegard, that the upper layers of the atmosphere are probably composed largely of the variety of oxygen gas called ozone. Then there is a third and older theory, still held by many students of the atmosphere, that these upper layers are composed in the main of light gases like hydrogen and helium.

In this disagreement among the doctors the radio expert can do no more than wait for further facts, at least so far as he is interested in the material composition—the dustiness or gaseousness—of these upper levels of the air. But another line of attack on the radio properties of the Heaviside region is possible and has been suggested by Professor W. F. G. Swann of the University of Minnesota.

In an address last spring on "Unsolved Problems of Cosmical Physics,"† Professor Swann pointed out that the Heaviside Layer, if it exists at all, has for one of its main properties the fact that it conducts electricity. It would have, therefore, magnetic as well as electric properties, and some of these magnetic properties ought to affect, perceptibly, the magnetic conditions on the surface of the earth. For example, the gas (or dust) of the Heaviside Layer ought to have a tide in it just as has the ocean, and this tide should cause a slight daily variation in the strength of the magnetic field of the earth at the ground surface, the field which makes magnetic needles point toward the pole.

Now it happens that such a daily variation in the magnetic field of the earth does exist and has been known for some time to the students of terrestrial magnetism. The variation has practically the same form, says Professor Swann, that it would have if it is due to the daily tide in the Heaviside Layer. Or, if one reverses the calculation, it is possible to take the data of magnetic variation on the earth's surface and to compute therefrom the size, conductivity and other properties of a Heaviside Layer able to produce these variations.

Professor Swann quotes the calculations of Schuster made in this way. The Layer would have, he says, a thickness of about 180 miles. The gas pressure in it would be about one millionth as much as on the earth's surface. The electrical conductivity would be about 1,000,000,000 times as great as that of ordinary air. This means that the entire circumference of the Layer, all the way around the earth, would have only about as much resistance for electricity as has a film of ordinary air 1/80 inch thick.

These specifications for the Layer make it quite suitable for the duty that radio engineers suspect it of performing, that is the reflecting of radio waves back toward the earth so that distant transmission is made possible. The radio public should urge that this magnetic way of exploring the contents of the inaccessible attic of our atmosphere be undertaken still more definitely by the magnetic observatories.

* "A Theory of Meteors." Proceedings of the Royal Society (London), vol. *102A*, pages 411-437 (January, 1923).

† *Journal of the Franklin Institute*, vol. *195*, pages 433-474 (April, 1923).

Fading Tests Yield a New Theory of Radio Transmission

THE comprehensive tests carried out by the Bureau of Standards and the American Radio Relay League on the phenomena of fading have now been described in a report* which is summarized by its authors in the following words.

"During the years 1920 and 1921 a study was made of the variations of intensity of received radio signals of high frequency or short wavelength. The investigation was conducted with the assistance of the American Radio Relay League. During the tests, from 5 to 10 radio stations transmitted signals in succession. These signals were received simultaneously at about 100 receiving stations, whose operators were provided with forms for recording the variation in the intensity of the signals as received. Particular attention was given to the intensity of signals, the fading of signals, the prevalence of strays or atmospheric disturbances, and the weather conditions existing at the time of transmission. An analysis was made of the reports received, and summary tables are given which point out possible relationships between the received signal intensity, fading and strays, and the weather conditions existing at the time.

"It is concluded that the sources or causes of fading are intimately associated with conditions at the Heaviside surface, which is a conducting surface some 60 miles above the earth. Daytime transmission is largely carried on by means of waves moving along the ground, while night transmission, especially for great distances and short waves, is by means of waves transmitted along the Heaviside surface. Waves at night are thus free from the more uniform absorption encountered in the daytime, but are subject to great variations caused by irregularities of the ionized air at or near the Heaviside surface. These variations probably account for fading."

* "A Study of Radio Signal Fading," by J. H. Dellinger, L. E. Whittemore and S. Kruse. Scientific Papers of the Bureau of Standards, No. 476 (being vol. *19*, pages 193-230), issued September 25, 1923. There was a preliminary report of this investigation by Dellinger and Whittemore in the *Journal of the Washington Academy of Sciences*, vol. *11*, No. 113 June 4, 1921.

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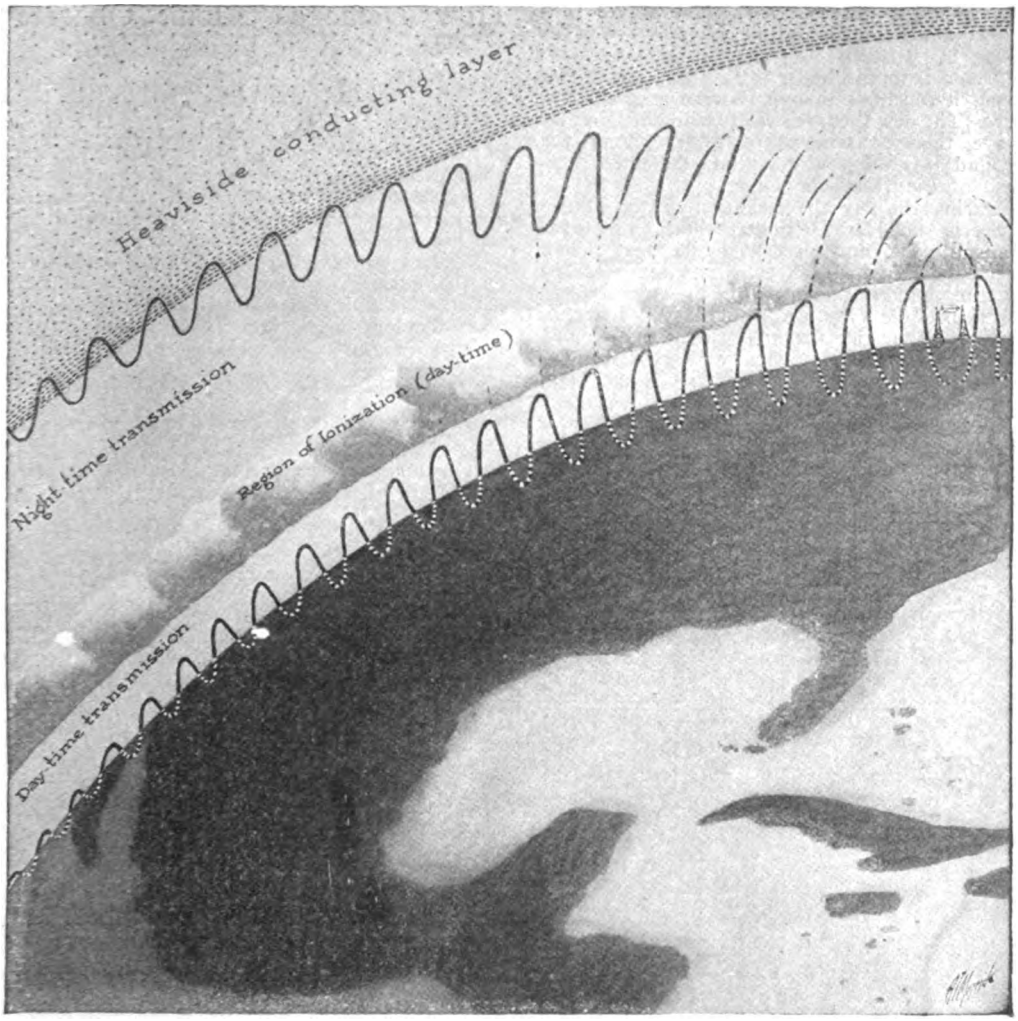

From a drawing made for POPULAR RADIO by Arthur Merrick

THE NEW DUAL-WAVE THEORY OF RADIO TRANSMISSION

One wave travels along the surface of the ground, the other travels along the under surface of the Heaviside Layer. During the day the upper wave cannot penetrate the region of ionization in the cloud layer; accordingly it is suppressed. This is why transmission is better at night.

To many radio engineers the most interesting feature of this report will be the suggestion contained in the last three sentences of the preceding quotation. This is the theory that long-distance radio transmission may involve *both* the Heaviside Layer and the gliding wave along the surface of the ground.

Readers of POPULAR RADIO are already familiar with the arguments advanced by the advocates of these two opposing theories of radio transmission, the Gliding-wave theory and the Heaviside Theory*. According to the first of these theories, the waves glide along the surface of the ground (or the sea) much as the waves of line radio follow along the guiding wire. According to the usual form of the alternative or Heaviside-layer theory long-distance transmission is not due to gliding waves at all but to waves *reflected downward* from the under surface of the Heaviside Layer and thus brought back to the surface of the earth.

The new theory suggested by Dr. Dellinger and his associates is different from either of these. It assumes that during the day transmission is mainly by the wave that follows along the surface of the ground; that is, daytime transmission follows the Gliding-wave theory. But at night, says Dr. Dellinger, the transmis-

*See, for example, the article by Dr. R. A. Fessenden in POPULAR RADIO for November, 1923, and the earlier articles by Dr. Elihu Thompson, Sir Oliver Lodge, Major General George O. Squier and others there referred to.

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sion is of a different sort. The waves then travel along the Heaviside Layer as well as along the ground. But they are not so much *reflected* from the Layer as they are *transmitted* along it much as though it were a conducting wire. The new theory is really a double Gliding-wave theory. One wave glides along the ground; the other glides along the under surface of the Heaviside Layer.

During the day the condition of the atmosphere is such, Dr. Dellinger thinks, that waves transmitted from terrestrial stations cannot reach the Heaviside Layer. They are absorbed in the middle portions of the atmosphere. Therefore the only wave that reaches distant stations is the one that goes along the ground. But at night the air is less absorptive for the waves, they reach the Heaviside Layer and follow along it as they do along the ground. The received signal is, therefore, stronger at night since it then includes *both* of the gliding waves, the lower one along the ground and the upper one along the Heaviside Layer.

How Damaged Atoms Operate New Kind of Vacuum Tube

At a recent meeting of the Institute of Radio Engineers Mr. Harold P. Donle* described a new vacuum tube that involves several novelties in tube principles, notably the fact that the tube operates not so much by the aid of electrons as by means of what are called ions. These ions are merely atoms that have been damaged by the loss of one or more electrons.

Readers of recent articles in Popular Radio on the modern investigations of the structure of atoms† will remember that the atoms of every kind of matter are really complex systems built up out of electrons and central

*"New Applications of the Sodion Detector." Meeting of the Institute of Radio Engineers, New York, October 10, 1923. The full paper will appear shortly in the Proceedings of the Institute.

†See, for example, "700,000,000,000,000,000,000,000 Electrons for a Cent," in Popular Radio for January, 1924.

Kadel & Herbert

WILL RADIO HELP THE HARD OF HEARING?

Many persons have reported that they can hear radio concerts better than they hear ordinary spoken sounds. Dr. Paul V. Winslow, a well-known ear specialist of New York City, is testing the truth of this idea and is using radio, also, in the treatment of partial deafness. The theory is that listening to radio will give much-needed practice to imperfect ears. The nerves of hearing are re-educated in perceiving sound combinations. At the same time the mechanical parts of the ear are exercised and improved, just as muscular exercise strengthens the body as a whole.

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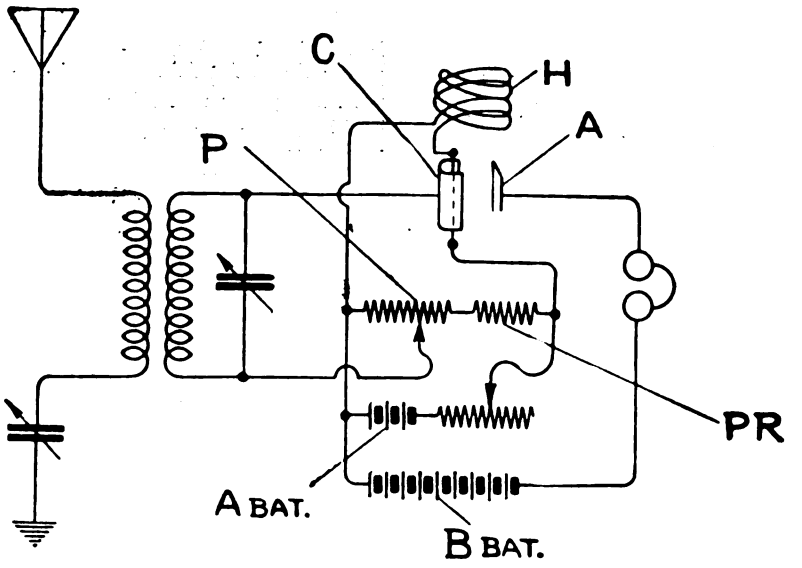

CONNECTIONS FOR THE TUBE THAT WORKS WITH IONS

A is the plate and C is the collector, which is the device that takes the place of the grid. The filament is indicated by the dotted line inside the curve of the collector. It is in series with the coil H, which serves to heat the tube and produce the ionization of the sodium atoms.

nuclei in a good deal the same way that our solar system is built up out of the planets and the central sun. The electrons in an atom revolve in orbits around the central nucleus and some of these orbits are quite distant, relatively, from the nucleus; even farther away, in proportion, than the outermost planet of our system is from the sun and from the inner planets like the earth. Sometimes these far-out electrons of an atom get loose and fly away or are hit by other electrons and knocked off. Then the atom is shy one electron, just as our solar system would be minus one planet if the outermost one flew off or was hit by some wandering star and driven out into space.

This process of losing electrons from an atom is what is called "ionization." The part left behind is called an ion. There is always a good deal of ionization inside a vacuum tube of any kind. The atoms of gas that are left in it (for the vacuum in the tube is never quite perfect) are being hit all the time by the flying electrons from the filament and many of the atoms have an electron knocked out of them so that they become ions.

Now some kinds of atoms are especially susceptible to ionization. For example, the atoms of the chemical element sodium (a silvery white metal that is so active chemically that it catches fire spontaneously in the air) are very easily ionized. Each of these sodium atoms has a total of eleven electrons that revolve as planets inside it and the eleventh one of these electrons moves in an orbit that reaches a long way out from the center of the atom. It corresponds to the outermost planet of our solar system.

Accordingly this outermost electron escapes very easily from the atom and goes off by itself, leaving the sodium *ion*, that is a sodium atom that has only *ten* electron planets instead of the normal eleven. This ion has, also, a positive electric charge just equal in quantity to the negative charge of the one electron that it has lost.

These sodium ions are used to operate the new Donle tube. The tube has a plate and a filament much as do the ordinary three-electrode tubes. It has no grid, this element of the tube being replaced by a metal half-cylinder placed behind the filament instead of between the filament and the plate. The tube is pumped to the highest possible vacuum and then some atoms of sodium are introduced into it. To keep this sodium in the state of a gas during the operation of the tube, and also to facilitate the ionization of the sodium atoms the tube is heated by a small heating coil, in series with the filament, which coil is wound non-magnetically around the outside of the glass. There is a second glass bulb outside of this in order to protect the heating coil and prevent the cooling of it by the air.

This arrangement gives many billions of sodium atoms in the space inside the inner tube. A large proportion of these atoms lose their eleventh electron and become sodium ions. These ions operate the tube just as electrons operate the ordinary tube, with two exceptions. *First*, the ions are positive, not negative; accordingly they move in the opposite direction to the electrons when placed in the same electric field. *Second*, the ions are far heavier than electrons and accordingly they move much more slowly.

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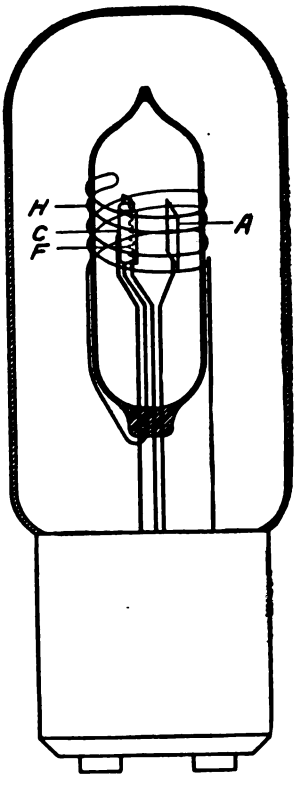

SODION TUBE ASSEMBLY

H is the heating coil; C the collector; A the plate, and F the filament. Note the outer protecting bulb of glass.

The detailed theory of the operation of the tube is quite complicated and persons interested in it must refer to Mr. Donle's paper in the Proceedings of the Institute. The results of its operation are, essentially, as follows:

The tube is a detector only. It will not oscillate nor will it respond at all to a single radio-frequency impulse. The time occupied by a single radio-frequency cycle is too short to affect the tube. But the time of an audio-frequency wave is much longer and this does affect the tube, so that the tube detects it. The tube has, it is claimed, many of the advantages of the crystal detector and the diode tube and avoids some of the outstanding disadvantages of these devices for detection, as well as being the most sensitive detector known. A hook-up for the use of the tube will be found on page 294 of this issue.

One application of the tube may prove to be of considerable value in radio research. This is the fact mentioned by Mr. Donle that the current in the filament-collector circuit (the "collector" is the semi-cylindrical plate that replaces the grid) is exactly proportional to the audibility of a signal at the receiving station. Accordingly a Donle tube connected with a current meter constitutes a direct-reading audibility meter. Mr. Donle has applied such a circuit to the recording of fading curves for the signals from WJZ and WGY. These fading investigations are now so much in the mind of the radio public that this use of the new tube may prove one of its most important services to radio science.

Technical Articles You Ought to Read

THE following brief reviews cover some recent papers of interest to radio amateurs, professional physicists and radio engineers. Translations, abstracts or photostat copies of these papers can be supplied in most cases at prices which will be quoted on application. Address "World's Laboratories Department," POPULAR RADIO.

"The Optimum Wavelength," by Leon Bouthillon, *Radio-Électricité* (Paris), vol. *4*, No. 11, *Bulletin Technique*, pages 41-45 (Aug. 15, 1923); No. 14, pages 52-57 (Oct. 1, 1923); No. 17, pages 68-76 (Nov. 15, 1923); to be further continued. A comprehensive mathematical discussion of the problem of selecting the best wavelength for the transmission of various kinds of signals between different varieties of transmitting and receiving apparatus. In French.

"The Nature of Light and Light Waves," by J. A. Fleming. *Wireless Review* (London), vol. *1*, pages 559-560 (Oct. 13, 1923); pages 587-589 (Oct. 20, 1923). Suggests a new theory of the structure of the universe according to which the ether is conceived as a complicated system of "ether tubes" or lines of force (also called "electrolines"). The theory seems not very different from the original "lines-of-force" conception of Faraday but is of interest in connection with present-day speculations concerning the nature of the ether.

"The Production of Small Alternating Potentials of Known Amplitude," by H. G. Möller and E. Schrader. *Jahrbuch der drahtlosen Telegraphie und Telephonie* (Berlin), vol. *22*, pages 56-72 (Aug., 1923). A full description of apparatus and method for producing electric oscillations of known frequency and amplitude by a loose-coupler method. A useful article for all experimenters with oscillating circuits. In German.

"The Torques and Forces Between Short Cylindrical Coils Carrying Alternating Currents of Radio Frequency," by W. A. Parlin. *The Physical Review*, vol. *22*, pages 193-197 (Aug., 1923). The results of comprehensive experiments show that coils carrying radio-frequency oscillations possess very slight attractions and repulsions, which can be ascribed only to the fact that the emission of a radio

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wave produces a repulsion or back-kick against the coil from which it originates. The discovery of this effect may prove to be very important for future investigations of the nature of radio waves and of the ether.

"The Transmission and Reception of Speech and Music in Radio Telephony," by N. W. McLachlan. *Beama* (London), vol. *13*, pages 285-292 (Nov., 1923); pages 366-369 (Dec., 1923). A comprehensive but thoroughly scientific discussion of the modulation, transformation and amplification problems involved in modern radio telephony. Will be especially valuable to the beginning radio engineer.

"Distortion in Radio Telephony," by H. A. Thomas. *The Wireless World* (London), vol. *13*, pages 225-229 (Nov. 14, 1923); pages 257-260 (Nov. 21, 1923). A paper before the Radio Society of Great Britain, similar in character to that of McLachlan referred to above.

"Forced Oscillations in Self-maintained Oscillating Circuits," by W. A. Leyshon. *The Philosophical Magazine* (London), vol. *46*, pages 686-698 (Oct., 1923). A scientific report of some of the investigations being carried out by Prof. W. H. Eccles of Finsbury Technical College, London, on the subject of forced oscillations. A "forced oscillation" means that an oscillating electromotive force of different phase or even of slightly different frequency, applied to a circuit that is already oscillating, will sometimes pull this circuit into tune with the applied electromotive force. The matter is of importance in the theory of the heterodyne and in many other radio problems. The present paper contains, also, an account of experiments with the method of Lissajous for indicating phase differences between two oscillations by means of a steel needle vibrating in the joint magnetic field of the two circuits.

"Multiple Earthing Systems," by G. W. O. Howe. *The Electrician* (London), vol *91*, pages 266-267 (Sept. 14, 1923). A brief account of the methods of avoiding earth-current losses in antenna systems, especially of the multiple earth plates recently installed at Nauen and St. Assise.

"A Study of Net-work Antennas," by R. Villem. *Radio-Électricité* (Paris), vol. *4*, No. 11, "*Bulletin Technique*," pages 33-40 (Aug. 15, 1923). A mathematical and theoretical discussion of the design of antennas of this type. There is a correction to the original paper in No. 14 of the same journal, "*Bulletin Technique*," page 57 (Oct. 1, 1923). In French.

"Contribution to the Study of Amplifiers of Very Low Frequency," by P. Lejay. *L'Onde Électrique* (Paris), vol. *2*, pages 521-534 (Sept., 1923). Experiments and theoretical discussion of the design of audio-frequency amplifiers and transformers. In French.

"The Design of Inductances for High-frequency Circuits," by C. L. Fortescue. *Journal of the Institution of Electrical Engineers* (London), vol. *61*, pages 933-939; discussion, pages 939-943 (Aug., 1923). Complete theoretical and practical discussion of this important problem, including the limitations due to the space factor, the design for minimum R/L, and other points. Valuable to the radio engineer.

"Curves for the Design of Variable Air Condensers," by F. Bedeau. *L'Onde Électrique* (Paris), vol. *2*, pages 508-520 (Sept., 1923). A discussion of condenser theory that will be useful to experts. In French.

"Description of a Series of Single-layer Inductance Coils Suitable for Radio-frequency Standards," by J. L. Preston and M. S. Strock. Letter Circular No. 103 of the U. S. Bureau of Standards. Issued October, 1923. How to make coils such as are used with the Bureau of Standards wavemeters. Copies of the Circular are procurable from the Bureau, Washington, D. C.

"The Measurement of Power Losses in Dielectrics," by L. Hartshorn. *Beama* (London), vol. *13*, pages 89-99 (Aug., 1923). An account of the experiments carried out at the National Physical Laboratory, England. Important to all engineers who work with insulating materials, especially the solid insulating materials used in radio apparatus.

"Electrical Loudspeakers," by A. Nyman. *Journal of the American Institute of Electrical Engineers*, vol. *42*, pages 921-927 (Sept., 1923). An analysis of the electrical and magnetic factors involved in the design of loudspeakers. Testing methods are described also. This will be an invaluable article for all engineers engaged in problems of loudspeaker improvement.

"Theoretical and Experimental Study of the Telephone Receiver," by A. E. Kennelly. *The Post Office Electrical Engineers' Journal* (London), Vol. *16*, pages 144-171 (July, 1923). This is a translation of the lectures delivered by Prof. Kennelly, of the Massachusetts Institute of Technology, at the French School of Posts and Telegraphs early in 1923. It is a useful summary of present information for all persons interested in the design of telephone receivers.

"Electrostatic Voltmeters," by R. R. Ramsey. *QST*, vol. *7*, No. 3, pages 18-20 (Oct., 1923). A simple voltmeter based on the principal of the gold-leaf electroscope or of the familiar pith-ball experiment. It can be constructed by anyone and has been applied to the measurement of voltages between 75 and 3,000 volts.

"Vacuum Tubes as Power Oscillators," by D. C. Prince. *Proceedings of the Institute of Radio Engineers*, vol. *11*, pages 275-313 (June, 1923); pages 405-435 (Aug., 1923); pages 527-550 (Oct., 1923). An excellent treatise on the theory and operation of power tubes used either for radio transmission or for other engineering purposes. It is complete, practical and authoritative.

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"The Axially-controlled Magnetron," by Albert W. Hull. *Journal of the American Institute of Electrical Engineers*, vol. *42*, pages 1013-1018 (Oct., 1923). A description, by the discoverer, of the theory and operation of the type of vacuum tube in which the movement of the electrons is controlled by the magnetic field set up by the alternations of current in the filament, no grid being necessary. A photograph of this tube was published in POPULAR RADIO for January, 1923.

"The Mobilities of Electrons in Air," by Leonard B. Loeb. *Proceedings of the National Academy of Sciences* (Washington), vol. *9*, pages 335-340 (Oct., 1923). A report on one of the many investigations now going on in American laboratories (this paper is from the University of Chicago) on the behavior of electrons in gases. The theory of this behavior, when we know it completely, will be invaluable to the operation and design of vacuum tubes, especially those that contain some gas and are therefore "soft."

"Some Experiments Illustrating the Electrical Properties of Neon Lamps," by Philip R. Coursey. *The Wireless World* (London), vol. *12*, pages 700-704 (Aug. 22, 1923); discussion, pages 778-779 (Sept. 5, 1923). The neon lamp is filled with the rare gas, neon, a tiny fraction of which is contained in the atmosphere. This gas glows when a current is passed through it between two electrodes, the necessary potential being some 200 volts or less depending on the pressure and temperature of the gas. Such lamps are available commercially in England and can be used in various radio experiments; for example, as detectors in wavemeter circuits, as indicators that the current is flowing in oscillators, and the like. Small neon-filled tubes are used in America as ignition gauges for automobiles and can be employed similarly in radio circuits.

"Experimental Valve Making," by H. P. Warren. *Popular Wireless* (London), vol. *4*, page 31 (Sept. 8, 1923). Hints to the amateur who intends trying to make his own vacuum tubes. ("Valve" in England, means vacuum tube.)

"The Helicoidal Molecular Pump," by F. Holweck. *L'Onde Électrique* (Paris), vol. *2*, pages 497-503 (Sept., 1923). A description, by the inventor, of the special vacuum pump designed for use with the demountable power tube now under test in the Eiffel Tower station at Paris. This tube was described in POPULAR RADIO for December, 1923, page 525. The article cited is in French.

"Physical Measurements of Audition and Their Bearing on the Theory of Hearing," by Harvey Fletcher. *Journal of the Franklin Institute* (Philadelphia), vol. *196*, pages 290-326 (Sept., 1923). A summary of the important investigations made in the laboratories of the Western Electric Company on the relations between sound waves in the air (as measured and produced by *physical* methods) and the *sensations* of hearing which these waves produce in the human ear. This fundamental information is the basis of all theories for the design of loudspeakers, telephone receivers and all similar instruments, as well as of the telephonic amplifiers for the use of the deaf.

"Wireless Direction Finding in Steel Ships," by C. E. Horton. *Journal of the Institution of Electrical Engineers* (London), vol. *61*, pages 1049-1056; discussion, pages 1056-1060 (Sept., 1923). A comprehensive discussion of the effects of metals in the ship on the readings of direction finders. Includes the use of multiple antenna systems. There is also a discussion of laboratory methods for investigating the effects of metals on the propagation of radio waves.

"Recent Developments in the Application of Wireless Telegraphy to Shipping," by John A. Slee. A paper before the meeting of the British Association for the Advancement of Science, Liverpool, September 14, 1923. Reported in *The Electrical Review* (London), vol. *93*, pages 443-444 (Sept. 21, 1923). A general account of recently developed high-speed devices for ship-to-shore telegraphy, of filters for reducing interference in this traffic, of duplex telephony for ship use, of the revolving-beam radio lighthouse at Inchkeith, and of experiments on apparatus for direction finding on shipboard by the use of long waves.

"The Control and Navigation of a Model Ship by Wireless," anonymous. *The Model Engineer and Electrician* (London), vol. *49*, pages 269-271 (Sept. 6, 1923). Detailed description of a small boat that can be controlled from shore by radio signals. It can be built by any amateur of a mechanical turn of mind.

"Report of the Special Broadcasting Committee Appointed to Advise the British Postmaster General on the Broadcasting Situation." Issued by H. M. Stationery Office, London, Oct., 1923. Price, postfree, 10 pence. An important document to persons interested in the future of broadcasting and the possible necessity of its further legal control in the United States.

"The Amateur's Part in Wireless Development," by W. H. Eccles. Presidential address to the Radio Society of Great Britain. Printed in *The Wireless World* (London), vol. *13*, pages 50-54 (Oct. 10, 1923). An article recounting some of the important services of the amateur to radio, services which do not seem to be as clearly recognized by British officialdom as they have come to be by the authorities in the United States.

"Radio Signals of Standard Frequency and Their Utilization." Circular No. 92 of the U. S. Bureau of Standards. Describes the standard frequency signals sent out at intervals by the Bureau of Standards, and how these may be used to calibrate wavemeters or transmitters. A limited number of copies are available at the Bureau for those having real use for them.

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ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

Most of the Broadcasters Are in North America

THE tremendous advance of broadcasting in the United States and Canada, as compared with the rest of the world, is indicated by the fact that this continent possesses over 600 licensed broadcasting stations while all other countries combined have less than 50.

* * *

Another Record for Amateur Radio

AMATEUR communication between America and Asia has been attained. According to an announcement of the American Radio Relay League, Mr. Charles York of Tacoma, Washington, has been in momentary communication with a Japanese amateur. This leaves Africa as the only continent (so far as we know) which has not been reached by the American amateurs. Our signals were first heard in England on December 8, 1921, which was the initial instance of amateur communication across the ocean. Australia and South America have been reached since then. A notable instance of communication with the European mainland was described by Captain Deloy, French 8AB, in POPULAR RADIO for February, 1924.

* * *

The Most Powerful Radio Station in the World

THE Poulsen arcs of the great radio station in the Malabar Mountains of Java draw 2,400 kilowatts, which is probably the largest power used by any single transmitter in the world. This is enough power to light nearly fifty thousand ordinary electric lamps. The aerial of this station is fastened to the side of a mountain and rises nearly 2,000 feet above the station.

* * *

Newest Demountable Tube Produces 15,000 Watts

THE Holweck demountable vacuum tube, described in POPULAR RADIO for December, 1923, has been constructed in a new and enlarged model having a power of 15 kilowatts. The new super-power tube is under test in the Eiffel Tower station where the former tubes were tested. Its construction has not been described publicly, but it is believed to differ very little from the former model.

Two Vacuum Tubes in One

A NEW French invention, the Junot vacuum tube, contributes to radio science the idea of a tube containing two filaments. Only one is used at a time, but when the first filament has burned out or broken a simple adjustment inserts the second filament in the circuit in place of the damaged one, thus giving the tube a life just twice as long as the life of the usual one-filament tube.

* * *

Line Radio Replaces the Direct-current Telegraph

THE methods and apparatus developed for use in radio are replacing, one by one, the older methods of nearly all branches of electrical engineering. One of the most notable to feel this revolution is wire telegraphy. The older method of sending dots and dashes by direct current permitted only one message for each pair of wires. Line radio multiplies this many times, for a separate message can be sent simultaneously for each separable band of frequencies. Carrier-current (line radio) methods are now in use in Europe employing alternating currents as low as 400 cycles a second, and from this on up into radio frequencies, thus giving scores of separate message channels over the same wire.

* * *

Radio Closes in on the Secrets of the Magnetic Pole

THE northernmost magnetic observatory ever erected in the world has been set up near the ship of the MacMillan expedition. According to a news note by Science Service the magnetic observations are in charge of R. H. Goddard of the Carnegie Institution, who accompanied the expedition for this especial purpose. It is proposed to study the phenomena of earth magnetism in the neighborhood of the magnetic pole itself. Some of the elusive secrets of this important but little-known subject may be solved. One of the great advantages of this new observatory over previous magnetic stations in the far north is that the radio apparatus of the MacMillan expedition permits the magnetic observer to keep in touch with other magnetic laboratories all over the world.

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England Hears American Broadcasting on Crystal Sets

THIS is neither the newest radio lie nor a freak record. It is the result of the latest development of relay broadcasting. Concerts from American stations, notably from KDKA, have been picked up in England, amplified and relayed from the stations of the British Broadcasting Company. Thus we come one step nearer to something that POPULAR RADIO has been predicting for months—international broadcasting.

* * *

Does Rain Cause Static?

READERS of POPULAR RADIO for February, 1924, will remember the interesting relation found by Mr. Watson-Watt between the fall of rain at a given locality and the apparent origin of static, simultaneously, at the same locality. *Popular Wireless* (London) has been collecting some observations made by British listeners concerning the occurrence of visible sparks about their radio sets, especially between the plates of the condensers. An interesting feature of the reports to *Popular Wireless* is that most of the instances reported occurred during a rainstorm or some meteorological equivalent. Rain drops are known to be electrified. Perhaps some valuable facts can be uncovered by studying the nature of radio transmission during rain. Have any American readers noticed static sparks in their condensers and was it raining at the time?

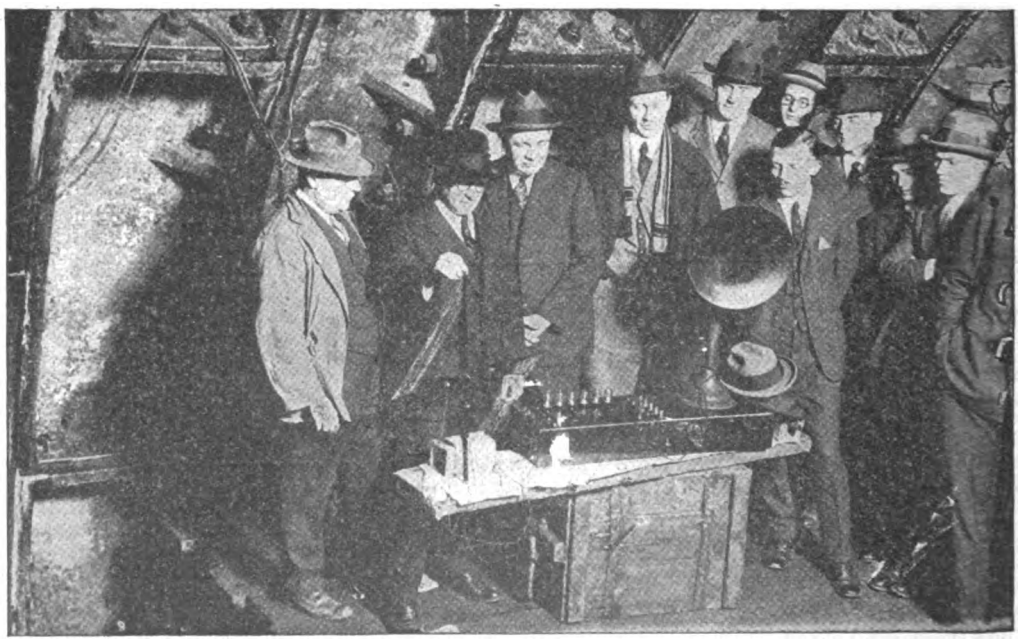
New European Broadcasting Stations

Two new short-wave stations are now on the ether in Europe. One at Brussels, Belgium, transmits each evening from 8:30 to 9:30 (3:30 to 4:30 P.M., New York time) on 410 meters. The second, at Rome, is on 450 meters. The government of Italy has not yet approved regular broadcasting, so the Rome transmission is still experimental. It occurs, usually, from about 10:30 to about 11:30 A.M., New York time. There is also an occasional experimental transmission from PTT at Madrid, Spain, on wavelengths between 400 and 700 meters. If you hear any of these stations let us know.

* * *

Radio and the World State

IN A recent thoughtful article in the New York *Evening Post,* Professor Preserved Smith of Cornell University points out that the world possesses already at least one element of that international world community which all historians and most statesmen agree in believing to be desirable if not inevitable. This is the existence already of a large measure of international co-operation among professional scientists. Quite true, but Professor Smith omits to mention that one group of scientists, the radio amateurs, not only possess such co-operation by means of publications and letters, but have the inestimable advantage of continual acquaintance through the ether. Amateur radio may prove a potent force for peace.



Underwood & Underwood

RADIO RECEPTION BENEATH A RIVER

In a recent test in the vehicular tunnel now being constructed to connect New York and New Jersey broadcast programs were received when the apparatus was ninety feet below the surface of the river. Together with the earlier experiments by the United States Bureau of Mines and in England, this test shows that radio may be of value in communicating with men entombed underground by disasters.

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Marconi Co., London

BAND CONCERTS IN A LONDON PARK—BY RADIO

The approach of the summer season suggests the possibilities of using radio receiving sets and loudspeakers for giving evening concerts simultaneously in the parks of American cities. Successful experiments have been made in London and Paris.

Do Sunspots Effect Radio Reception?

RECENTLY Dr. L. A. Bauer of the Carnegie Institution told the American Association for the Advancement of Science that he had discovered a close connection between the occurrence and character of spots on the sun and the phenomena of atmospheric electricity. The details remain to be worked out, but that there is a close linkage of some sort seems to be beyond question. Since the phenomena of static are associated, beyond doubt, with some feature of the electrical changes in our atmosphere, this new observation by Dr. Bauer is of great interest to radio engineers. It may be that we will be looking for sunspots soon in order to decide whether or not it will be worth while to try for DX records that night.

* * *

New Wavelengths of British Stations

THE wavelengths of the eight broadcasting stations operated by the British Broadcasting Company have been rearranged. At last advices the following are the wavelengths in use:

350 meters, 2LO, London.
370 meters, 5NO, Newcastle.
385 meters, 6BM, Bournemouth.
400 meters, 2ZY, Manchester.
420 meters, 5SC, Glasgow, Scotland.
435 meters, 5WA, Cardiff, Wales.
475 meters, 5IT, Birmingham.
495 meters, 2BD, Aberdeen, Scotland.

New Words that Radio Fans Already Know

IN an address before the recent meeting of the American Association for the Advancement of Science, the distinguished physicist, Mr. John Mills, criticised the makers of engineering text-books for using still the outworn terms of older electrical and physical theory. The engineering terms of the future will be, he said, such things as electrons, ions, protons, atomic nuclei and quanta of energy. Undoubtedly, and in this new engineering the radio man will have the great advantage of familiarity with exactly these terms that Mr. Mills says the engineers must learn to use. For it is these ideas, little used in the older branches of engineering, that the radio engineer must learn about first of all.

* * *

Apartment Superintendent Becomes Radio Policeman

THE annoyance of re-radiation from regenerative receivers has become so serious in many parts of New York City that Mr. Louis Doty, superintendent of a large apartment house, has insisted, says the New York *Sun and Globe*, upon inspecting every radio set in the apartment house before the installation of an antenna is permitted. If the receiver is of a type from which re-radiation is possible Mr. Doty, who is a competent radio engineer, offers his assistance in modifying it so that annoyance to the neighbors will be impossible.

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The Loudspeaker Is Not a Legal Nuisance

SEVERAL suits have been brought recently in various parts of the United States to determine just what are the rights of the radio listener as compared with the rights of his neighbors. Loudspeakers, it must be admitted, are too often louder than they are intelligible. Many persons object to being annoyed by them, especially when the horn is outside or the windows are open. Do such objectors have the legal right to stop the performance and compel the discontinuance of noise audible outside the broadcast listener's own house? In at least one case, in Ridgefield Park, New Jersey, the local courts have said no. The radio fan has the same right to operate a loudspeaker inside or outside his premises as he has to operate any other sound-producing instrument, for example a phonograph or a cornet. However, it behooves the radio public to be generous and considerate in the exercise of its legal rights. The good-will of your neighbor is an important asset. Some day you may want to string an antenna across his lot.

Underwood & Underwood

A RADIO ANGELUS

The noon time-signals relayed by station WGY are put to practical use by C. J. Waldron, an ardent radio fan of Medusa, N. Y., who rings the church bell immediately upon receipt of the official U. S. announcement of the arrival of 12:00 o'clock.

Uses for Rare Chemical Elements in Radio

MANY new uses for rare metals have developed in the radio field. Some of them were demonstrated, says *Science,* at the recent Chemical Exposition in New York. Thorium is used in the special coated filaments for vacuum tubes. Tellurium, an element that has previously had no use at all, is finding its place in detector crystals. Selenium, a chemical twin of tellurium, has many uses in the electric light-detecting devices, including the various systems for sending pictures by radio or for recording radio messages on photographic films. Tantalum, long entirely useless, is the basis of a new rectifier for battery-charging purposes. Molybdenum, a chemical curiosity until the French used some of it for cannon linings in the recent war, is now a necessary element in the high-power vacuum tubes. Many of these metals, once known only to research chemists, are now regular commercial articles—thanks to radio.

* * *

Who Will Invent a Sterling Silver Radio Set?

THERE is an over-production of silver in the United States and the Bureau of Mines is looking for new uses for the metal in industry. It is suggested that some parts of radio sets might, with advantage, be made of silver. Silver has about seven percent more conductivity (for direct currents) than has copper. It is also somewhat more malleable and is much less easily corroded in the air. If you can suggest some new use for it the Bureau of Mines will be glad to hear from you.

* * *

Vacuum Tube Proves the Radioactivity of the Earth

THE fact that the substance of the earth itself, including all ordinary rocks and soils, is radioactive in the same way that radium is, though more faintly, has been proved recently by Professor Compton, of Princeton, and by Mr. T. E. Foulke using an electric-discharge tube built on the same principles as a vacuum tube. It is found that the rays coming from the ground produce enough ionization of the minute quantity of gas left in the tube so that a high-tension discharge through the tube is possible at any time, even without a hot filament to provide a source of electrons and ions. This continual ionization can be prevented by encasing the tube in lead which cuts off the rays coming from the ground.

* * *

England Discovers the Radio Worm

To the writing beetle, the book-worm and the bug that eats lead sheathing off the telephone cables we now must add the radio-set earwig. Mr. H. E. Adshead in the *Wireless World* (London) reports that so many of these humble insects have delighted to crawl into the hole of his telephone jack that it has been necessary to insert a small plug in order to keep them out. Some of the insects have been found even inside the cases of earphones.

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SELECTIVITY is the main consideration in a set that is to be used for pleasure or amusement. You want to be able to "pick" any program that is within the range of your instrument whether or not you can receive only the local or both the local and distant stations.

A set that is sensitive and enables you to receive distance, but that has not sufficient selectivity to tune out the local stations is worse than useless. You don't want to listen to opera from one station with a background or accompaniment of jazz leaking through from some other station.

You want a *selective* receiver whether it is a simple crystal set or a complicated multi-tube receiver, and remember this: the more sensitive a set is, the more selective it must be! Get a set that is selective, by all means.

* * *

IN a two-stage audio-frequency amplifier that is noisy it will sometimes help a lot, in eliminating howling and squeaks, to ground the negative filament connection at the "A" battery. This will place the filament circuits at ground potential and cut out the capacity troubles that cause the howls.

* * *

A RADIO set, like a chain, is no better than the poorest link used in it. Make all the links strong by using good parts. Cheap makeshift instruments make weak links.

* * *

GROUND your set on the water pipe. It is usually better than other grounds.

MANY uses can be found for a temporary connector made by detaching two Fahnestock connection clips from a worn-out dry battery and soldering the severed ends together. The connector joins cord tips conveniently when two or more headsets are used in series.

* * *

Do not let the acid from the storage battery spill on your clothes or on the carpets. It will eat a hole in the cloth. If you *should* spill any of this electrolyte on the carpet or your clothes make a solution of ordinary baking soda in water and wash the spot thoroughly with this solution, being sure to use plenty of the soda solution. Then finish with a good wash with plain water.

A solution of household ammonia in water will neutralize the acid just as well but the ammonia itself sometimes damages fine fabrics and a solution of baking soda, though slightly less convenient than the ammonia, is safer.

* * *

Do not let your single-circuit regenerative set *whistle* when you are trying to pick up a station. If you do, it will cause a similar *whistle* in your neighbor's receiver that will interfere with his reception. If everybody would observe this golden rule of silence the reception in our large cities would be much improved.

* * *

Do not run your antenna close to, or parallel with, the fifteen others now on the same roof.

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A HANDY indoor antenna system can be made from the ordinary desk telephone stand and a small tin pie-plate. Connect the radio set up in the ordinary way except that the antenna binding post on the set is connected directly to the pie-plate. Then take the desk telephone stand and set it on the pie-plate, and tune in the signals in the regular manner.

The theory of operation is this: The telephone line is grounded on the metallic frame of the telephone and the base of the telephone desk set acts as one plate of a condenser while the pie-plate acts as the other plate. The felt covering on the desk set acts as the insulation or dielectric. What you really will have is the telephone line acting as an antenna with the telephone-pie-plate condenser in series with it. The telephone company can have no objection to this use, as you will not be making any metallic connection to their lines. The way to hook up the outfit is shown below.

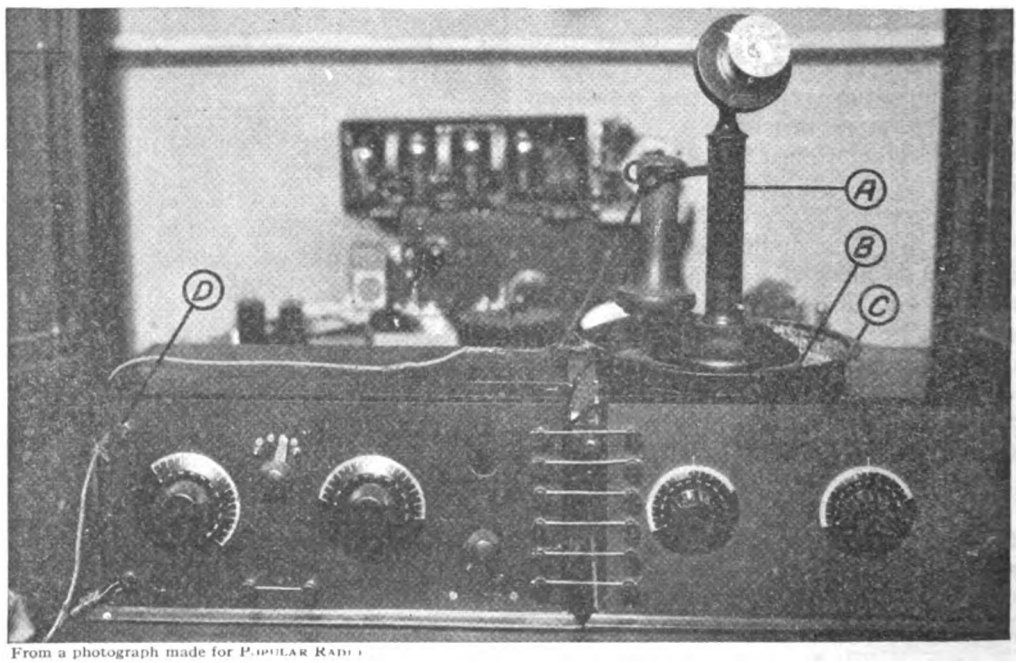
* * *

Do not use a variable condenser which has iron end-plates or an iron shaft, unless the iron is not placed near or in the magnetic field of the tuning coils. In other words keep any iron parts away from the tuning coils by a distance of at least two inches.

The iron, if it is within the magnetic field of the coils will materially reduce the strength of signals. This is the cause of relative failure in many sets where the builders have taken all the other precautions that they know about or have checked up the connections until they were sure they were right.

* * *

A RADIO set that is wired up poorly is like an apple with a worm-eaten core. It may look pretty from the outside, but it is worthless. *Moral:* do a good wiring job.



From a photograph made for POPULAR RADIO

THE PIE-PLATE-TELEPHONE ANTENNA

Take an ordinary pie-plate C, and attach a wire to it running to the antenna binding post D, of the receiving set. Then stand the telephone A, on the pie-plate as shown. The metallic parts of the telephone and pie-plate form the plates of a condenser of which the felt covering B of the telephone is the insulator or dielectric. This in no way interferes with the working of the telephone.

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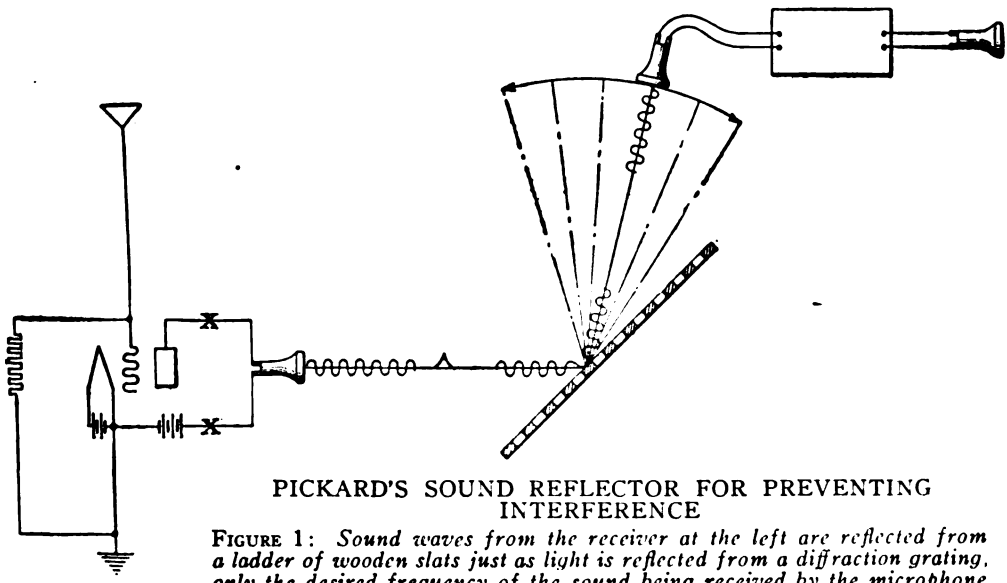
THIS *department will keep you in touch with the latest inventions of interest on which patent rights have been granted, and which are significant contributions to radio art.*

FIGURE 1: No. 1,460,439. INTERFERENCE PREVENTER. Invented by *G. W. Pickard* and assigned to the Wireless Specialty Apparatus Co. of Boston.

This device removes interference by dealing with sound waves rather than with the electric waves or impulses. The received signal (together with any interference that is present) is first converted into sound by a telephone. The sound waves thus produced are directed against a frame of wooden slats like the pickets of a fence. Sound waves of different frequency are reflected at different angles, as shown in the figure. A microphone placed at the proper point picks up the sound wave corresponding to the signal frequency. The waves of other frequencies (corresponding to the interference) fall on either side of the microphone and are not picked up. The purified wave received by the microphone may then be amplified or detected in any manner. The sound waves used for the purifying reflection may be of frequencies above the range of hearing. Students of physics will recognize in this device a principle analogous to that of the diffraction grating commonly used to separate light rays into their component wavelengths.

FIGURE 2: No. 1,460,734. WIRELESS DETECTOR. Invented by *W. H. Ruf* of Roselle Park, N. J.

This is a freak crystal detector made in the shape and size of a finger ring. By bending the finger slightly the two prongs of the mounting can be spread apart or brought together, thus moving the catwhisker over the surface



PICKARD'S SOUND REFLECTOR FOR PREVENTING INTERFERENCE

FIGURE 1: *Sound waves from the receiver at the left are reflected from a ladder of wooden slats just as light is reflected from a diffraction grating, only the desired frequency of the sound being received by the microphone above.*

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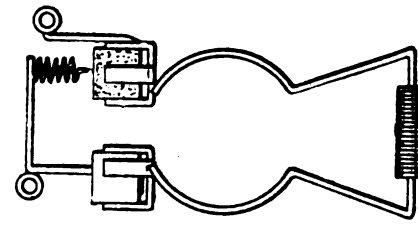
of the crystal in order to find the best point for reception. A similar device can be attached to a scarf pin.

No. 1,460,801; (no figure). DIRECTIONAL RECEIVING SYSTEM. Invented by *Robert H. Marriott* of Bremerton, Washington.

Ordinary periodic loop receivers are two-directional, that is, they will receive equally well in either of two opposite directions. This invention makes a periodic loop receiver *one-directional*. This is accomplished by a connection from the loop to ground through a vacuum-tube amplifier and an arrangement of circuits so that the signals from one direction are neutralized in the loop circuit by the loop-to-ground circuit while those in the reverse direction are not neutralized.

FIGURE 3: No. 1,462,057. SWITCH FOR VACUUM TUBES. Invented by *Peter I. Wold* and assigned to the Western Electric Company of New York.

This automatic switch for use with two vacuum tubes is devised for the purpose of instantly substituting a new tube in the circuit in case the tube originally in the circuit should fail. The cessation of current in the tube on the right of the drawing stops the pull of the solenoid on the magnet in front of it. The spring draws back the magnet and this instantly reverses the switch points and throws the left-hand tube into the circuit.



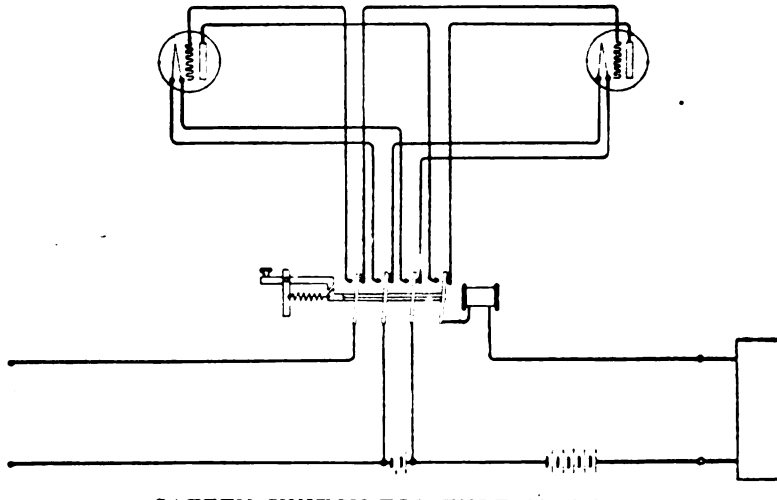
A RADIO FINGER RING

FIGURE 2: *This crystal mounting may be worn on the finger like a ring, the catwhisker being adjusted by bending the finger.*

Nos. 1,463,386 and 1,463,391; (no figure). RADIO-TELEGRAPH SYSTEM USING MAGNETIC RECORDS ON IRON WIRE. Invented by *W. L. Carlson* and *E. C. Hanson* of Washington, D. C.

These patents describe some of the details of a new process for recording and receiving radio signals by means of the well-known iron-wire telegraphone, the basic patents on which have now expired. The telegraphone, it will be remembered, is based upon the fact that an iron wire will retain a part of any magnetism impressed on it. If a wire, running between spools, passes near the pole pieces of an electromagnet, alternately magnetized and demagnetized, as, for example, the magnet of a telephone, a record of these magnetic alternations will be left in the wire and can be read from it by appropriate apparatus. It is now proposed to use such records in radio telegraphy.

FIGURE 4: No. 1,463,554. MOUNTING FOR CRYSTAL DETECTOR. Invented



SAFETY SWITCH FOR TUBE CIRCUITS

FIGURE 3: *If one tube burns out, this automatic magnetic switch operates instantly to disconnect the tube that has failed and replace it in the circuit with the other tube, previously unused.*

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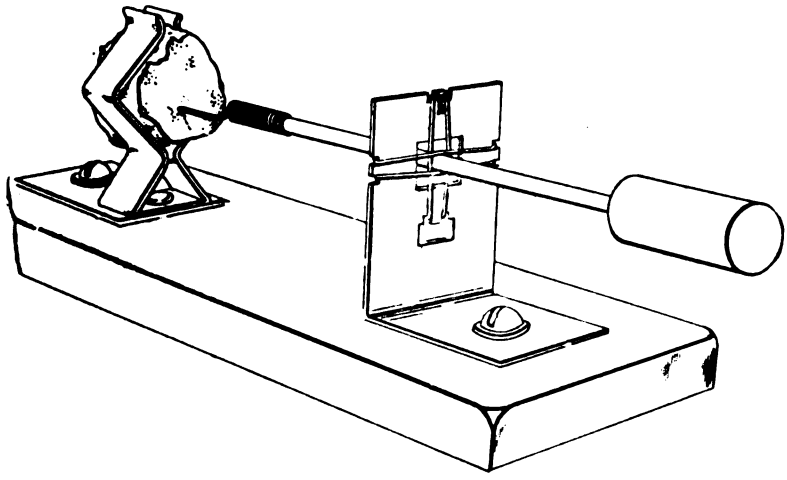


A CRYSTAL MOUNTING THAT IS EASY TO MAKE

FIGURE 4: *The loops of wire hold the supporting rod of the catwhisker tightly enough so that it will remain in position and yet loosely enough to permit moving it for readjustment.*

by *A. N. Pierman* of Newark, N. J.

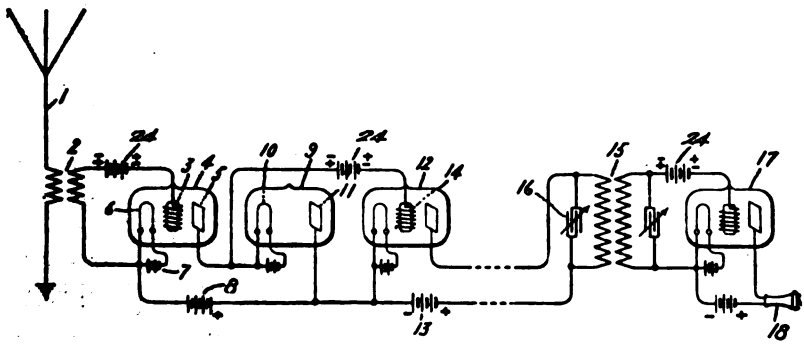
The nature of this simple mounting, easily made at home, is clear from the drawing. The rod that carries the catwhisker is held by friction between the two double loops of wire, these loops being held in place by the notches in the upright metal plate. The crystal itself is held between two simple metal clips.

No. 1,468,049; (no figure). RECEIVING SYSTEM. Invented by *A. H. Taylor* of Grand Forks, North Dakota, and assigned to the Radio Corporation of America.

This is a method of making a partial separation between signal impulses and static or other strays by using two or more antennas, one of which is more receptive to the signals while the others are more receptive to strays. The antennas are then opposed electrically so that the effect of the strays in the signal-receiving antenna is more or less neutralized. Detailed arrangements of circuits and antennas for this purpose are described and covered by the patent.

Nos. 1,468,059 and 1,468,061; (no figure). METHOD AND APPARATUS FOR RADIO SIGNALING. Invented by *R. A. Weagant* of Douglas Manor, New York, and assigned to the Radio Corporation of America.

These patents are applications of a theory



HOOK-UP FOR LANGMUIR'S POTENTIAL AMPLIFIER

FIGURE 5: *The second tube from the left is a diode and acts to limit the current possible in the first tube. This amplifies the potential variations in the first tube and these are then impressed on the grid of the third tube. The current variations in this third tube are translated into audible signals in the usual manner, through the transformer and the fourth tube.*

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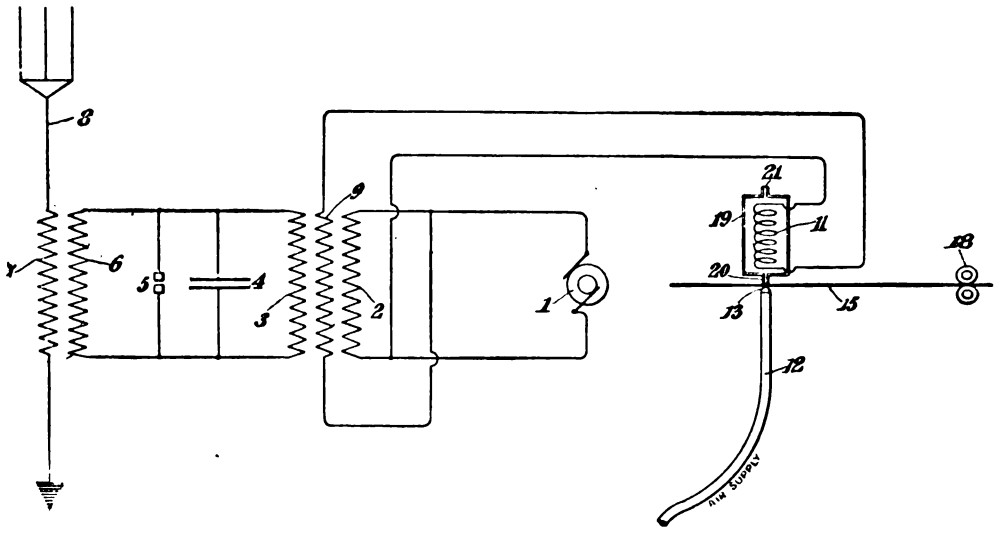

THE COLD-AIR TRANSMITTING KEY

FIGURE 6: *The coil inside the box at the right is of fine platinum wire. When the current flows this wire gets hot. Then when a blast of air is admitted to the box, through the flexible tube shown, the platinum coil is suddenly cooled. This lowers its electrical resistance. More current flows in the circuit and a signal is sent out through the transformer and antenna circuit at the left.*

formulated by the patentee to the effect that the impulses of static are mainly vertical while the signal impulses that one wishes to receive are mainly propagated horizontally. Circuits are arranged to receive selectively the up-and-down waves of static and to oppose these to the impulses in ordinary antennas, thus balancing out the effects of static in the latter.

FIGURE 5: No. 1,468,116. METHOD OF AMPLIFYING POTENTIAL VARIATIONS. Invented by *Irving Langmuir* of Schenectady, New York, and assigned to the General Electric Company.

This patent describes certain applications of the fact that the vacuum tube may be employed as a device to limit the amperage of an electric current. The emission of electrons from the filament forms an upper limit to the current that can pass through a tube, no matter what the potential of the grid. In the figure is shown Langmuir's application of this fact to the amplification of the *voltage* of radio signals, instead of the more usual method of amplifying their current strength. The second tube from the left (which has no grid) acts as the current-limiting device. The plate current of the first tube being thus limited, the difference of potential between the filament and the plate of this tube is variable and reflects, with considerable amplification, the potential variations on the grid of this tube. In this way the changes of voltage in the antenna circuit are greatly amplified before being impressed on the grid of the third tube. The same principles can be applied to the elimination of high antenna voltages due to static.

No. 1,469,349 (no figure). RADIO CONTROL SYSTEM. Invented by *A. L. Wilson* of Edgewood, Pennsylvania, and assigned to the Westinghouse Electric and Manufacturing Company.

A ratchet wheel at the receiving station is moved one notch by the radio signal whenever the corresponding wheel at the transmitting station moves one notch. This device is already a familiar one in many systems for distant control. The novelties of the patent lie in the means for controlling the ratchet movement by separate sets of modulated waves so that the accidental operation of the control by stray waves is unlikely. For these details the patent itself must be consulted.

FIGURE 6: No. 1,469,905. CIRCUIT-CONTROLLING DEVICE. Invented by *R. E. Hall* of Chicago, Illinois.

The patent describes a novel and interesting device which can be used either as a transmitting key or for many other purposes. It involves the idea of varying the current strength in a circuit by cooling a wire through which the current is flowing. It is well known that the electrical resistance of many kinds of wire changes with the temperature. By blowing a blast of cold air over a current-carrying coil, as shown in the drawing, the resistance of the coil can be varied and a signal thus produced.

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Radio instruments deserve the best panel you can buy. The appearance of your complete set depends on the panel material—its workability and its finish.

The right front door

YOUR radio set without a good panel would be like a house with its front door hanging on one hinge. Your radio instruments need a first-class panel just as much as that house needs a good strong front door. Mounting expensive instruments on a cheap panel is as big a mistake as trying to get distance with weak batteries in your circuit.

Use a Celoron panel

Celoron Standard Radio Panels satisfy the requirements of the most exacting set-builder. Celoron, a bakelite product, is one of the best insulating materials known. The U. S. Navy and U. S. Signal Corps testify to its high dielectric strength. Leading radio manufacturers mount their parts on it. Radio fans in all parts of the country use Celoron panel front doors in their sets.

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Highly polished, finished in lustrous black, mahogany, or oak, Celoron panels make a set that you will be mighty proud to show anybody. Drilling and engraving can not chip or feather the dense, hard surface.

Ask your dealer for a Celoron panel. You can identify it by the Celoron label that is on every panel.

Celoron Radio Panels come cut in the following standard sizes:

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2— 7 x 9 x 1/8
3— 7 x 12 x 1/8
4— 7 x 14 x 3/16
5— 7 x 18 x 3/16
6— 7 x 21 x 3/16
7— 7 x 24 x 3/16
8—12 x 18 x 3/16
9— 7 x 26 x 3/16

Special sizes can be cut to order from sheet stock. See your dealer.

Write for our free booklet, "Getting the Right Hook-Up," which contains diagrams and valuable radio information for the set-builder.

To radio dealers: Send for special dealer price list showing standard assortments.

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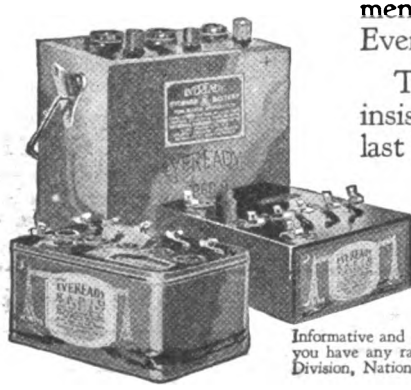
EACH Eveready Radio Battery represents thirty years of battery building experience. Each Eveready Battery represents millions of dollars invested in men, methods and machinery. Overseeing Eveready production is the greatest battery laboratory known to science, where every particle of raw material is required to pass Eveready's exacting tests. To insure Eveready serviceability, batches of Eveready Batteries are constantly being set aside for performance tests. And, finally, daily shipments keep dealers supplied with fresh Eveready Batteries, packed full of power.

To be certain of battery satisfaction, insist on Eveready Radio Batteries—they last longer.



NATIONAL CARBON COMPANY, Inc.
New York San Francisco
Headquarters for Radio Battery Information
CANADIAN NATIONAL CARBON CO., Limited
Factory and Offices: Toronto, Ontario

Informative and money-saving booklets on radio batteries sent free on request. If you have any radio battery problems, write to G. C. Furness, Manager, Radio Division, National Carbon Co., Inc., 128 Thompson Ave., Long Island City, N. Y.

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"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"

EVEREADY
Radio Batteries
—they last longer

The radio dry cell triumphant

For economical, satisfactory radio, light the filaments of your dry cell tubes with the Eveready Dry Cell Radio "A" Battery. Will unfailingly outlast any other at ⅛ ampere current. Full instructions for getting this Economical Eighth, on labels and in our booklets. This battery will exceed your expectations in economy and performance.

Equal to all demands

Power flows from your "B" Battery, power that gives life to your head-phones or loud speaker. Some tubes draw more "B" Battery current than others, but whatever the tube or tubes you use, Eveready "B" Batteries will give you maximum results. Eveready "B" Batteries are made in six sizes, for all possible uses. Always use the biggest possible battery, for it contains more energy in proportion to cost, and lasts longer. Where table space is limited, use the compact vertical 22½-volt "B" Battery No. 764. Its power is packed in small space.

This battery is a wonder worker

Eveready's biggest contribution to economical and more satisfying radio is the Eveready "C" Battery, a triple-use, universal battery. It will make the loud speaker respond with a new fullness and naturalness of tone, and save much money by making the "B" Battery last still longer. Connect it with the grids of audio frequency amplifiers and notice the big difference. Can also be used as an "A" Battery for 199-type tubes in portable sets, and as a "B" Battery booster. Eveready Radio Battery No. 771—use it!

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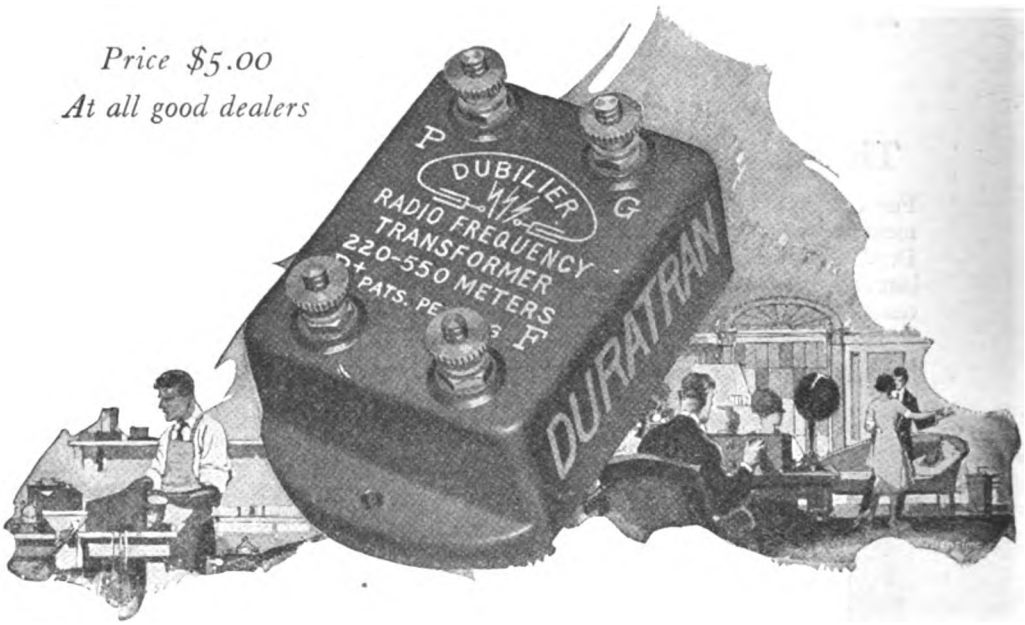
At all good dealers



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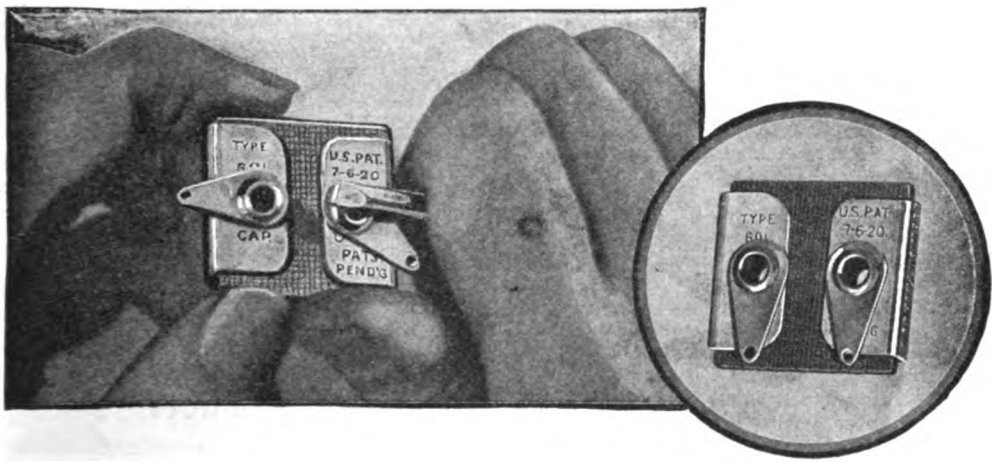
DEVICES



Dubilier Micadons for Any Circuit

Dubilier Micadon, type 601, is now made with extension soldering tabs. These facilitate mounting. The hot soldering iron need not touch the Micadon directly. Hence the capacity cannot be affected by the heat.

If Dubilier Micadons are to be mounted with screws simply push the soldering tabs aside or clip them and use the eyelets.

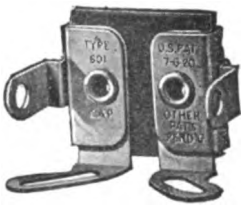
Thus the Dubilier Micadon; the standard of radio because of its permanent capacity, becomes even more convenient.

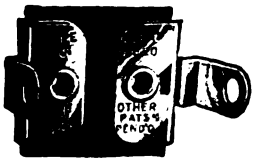
Dubilier Micadons are retailed at 35 cents up depending on style and capacity.

There is a Dubilier Micadon for every circuit requirement. If your dealer cannot supply Micadons, write to us.

Micadon type 601T has adjustable clips which slip over transformer and other binding posts.

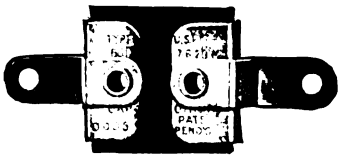
Micadon type 601G-T has clips to hold a fixed grid-leak and adjustable clips that slip over binding posts.





Micadon type 601G has clips to hold fixed grid-leaks (Grid-leaks not supplied with Micadons).

Micadon type 601L has eyeletted tabs that slip over the terminals of a variable grid-leak.



Write for free folder, showing ways of using Micadons in any circuit.

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The AFRICAN "Drum talk" of TODAY

BOOM! BOOM! BOOM! BOOM!

Thus the drum talk of the natives of Africa broadcasts to a radius of fifty or sixty miles the departure of white men leaving one village for another. To the weird Boom! Boom! of the huge drum, the travelers with their porters commence the perilous journey, knowing that their arrival is expected at the next village.

What a far cry this crude method of sending messages is from our modern, useful, pleasure-giving radio. And how very backward it seems when we consider the rapid strides made in the radio industry in just a few years time as exemplified by the Crosley story.

Three years ago Crosley Radio Receivers were unknown. To-day, The Crosley Radio Corporation is the largest manufacturer of radio receivers in the world. In every part of the United States, happy users are enjoying the beautiful concerts, useful lectures and valuable news that Crosley instruments unfailingly bring in from the distant points desired.

Real merit at moderate prices has brought about this Crosley popularity. Crosley engineers have continually kept abreast and perhaps a little ahead of the rapid advancement that radio has made.

We firmly believe that Crosley Radio Receivers are the best that have ever been offered to the public.

Insist upon Crosley Radio Apparatus
For Sale By Good Dealers Everywhere

Following is a List of the Most Popular Crosley Receiving Sets With Their Prices

Crosley Type V (formerly Ace) one tube regenerative	$20.00
Crosley Type 3 B (formerly Ace) three tube regenerative	50.00
Crosley Type 3 C (formerly Ace) consolette model	125.00
Crosley Model VI, two tube incorporating radio frequency	90.00
Crosley Model X-J, four tube, incorporating radio frequency	65.00
Crosley Model X-L, four tube consolette	140.00

The Crosley regenerative receivers formerly called Ace, listed above are licensed under the Armstrong U. S. Patent No. 1,113,149.

CROSLEY
Better-Cost Less
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CROSLEY MODEL X-J—Price $65.00

A 4 tube radio frequency set combining one stage of Tuned Radio Frequency Amplification, a Detector, and two stages of Audio Frequency Amplification. A jack to plug in on three tubes for head phones, the four tubes being otherwise connected to the loud speaker, new Crosley multistat, universal rheostats for all makes of tubes for dry cells or storage batteries, new condenser with molded plates, filament switch and other refinements add to its performance and beauty.

We believe that for bringing in distant stations it cannot be equalled.

Cost of necessary accessories from $40.00 up.

The Crosley Radio Corporation owns and operates Broadcasting Station WLW

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Here Is the Man—Here Is the Receiver

The amazing story of continued communication with the MacMillan Expedition, on the Steamer Bowdoin—frozen in somewhere near the North Pole—and with other distant points is here told by Mr. Len Weeks, Radio 9DKB, Minot, N. D.

December 30, 1923.

"I submit the following account of the use of the Ace Type 3B and the Ace Type V radio receivers for DX work, especially with WNP.

"Using the Ace Type 3B or Type V, I have heard the schooner Bowdoin radio WNP a total of seventeen times during November and December. On thirteen of these occasions communication was established. Thirty-four messages totaling several thousand words were received from the Bowdoin, including a 1500 word press dispatch, taken in 3 hours and 30 minutes. Twenty-two messages were sent to MacMillan and members of the crew. The greatest length of time between communications was nine days, of which four were spent away from the station. Signals were unusually readable and often uncomfortably loud on two steps.

"During the month of December Canadian 9BP, Jack Barnsley, has been on a vacation. During this time my station has been the main, but not the only, link between the North Greenland expedition and the United States. Most of the credit for this is due to the fine control of regeneration and ease of adjustment on the Ace sets. Having a wave length range that completely covers the amateur band, it was easy to quickly shift wave length in order to avoid interference.

"In addition to the above reception, 7AHB in Alaska and 6CEU in Hawaii have been copied several times. Of course stations on both the east and west coast are heard every night. It is nothing unusual to copy stations from every district in a night's work. I have discarded a higher priced three circuit set for I honestly believe that the ACE sets give greater receiving range both in miles and kilocycles."

January 5, 1924.

"Last night my second operator, Homer Stenerson, a man comparatively inexperienced in amateur work, successfully established communication with WNP, giving him a message and getting an acknowledgment. Many people seem to think that the results are due to expert manipulation. This is not the case, for on several occasions I have had other amateurs listening for WNP while I took a much needed sleep. Nearly always they were able to pick him up and hold him till I got on the job."

The above communications are merely samples of the continued proofs, voluntarily sent us, of the superiority of Crosley Instruments.

We believe that for bringing in distant stations they cannot be equaled.

And the Prices are Remarkably Low.

The ACE TYPE V—$20.00 **The ACE TYPE 3B—$50.00**

Write for Complete Catalog

THE CROSLEY RADIO CORPORATION

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316 Alfred Street **Cincinnati, Ohio**

The Ace Receivers mentioned above are now known as Crosley Receivers

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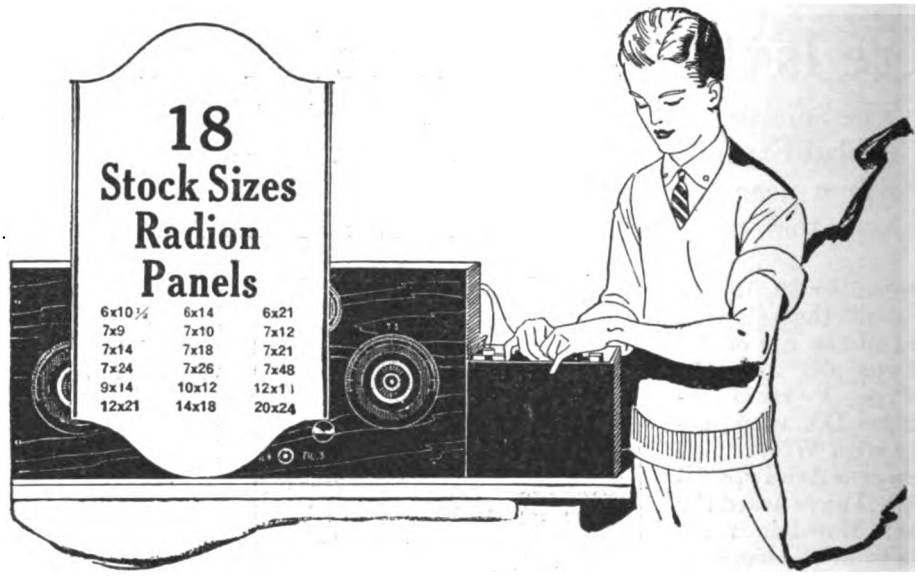

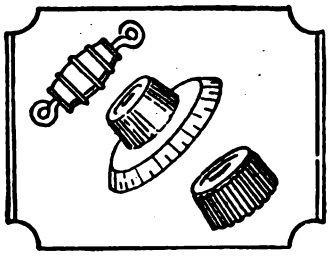

They Do Not Chip When Drilled

Drill, saw or engrave a Radion Panel. Use what tools you will, dull or sharp, this material will not chip or show ragged edges. Its proven electrical values make RADION the supreme insulation both from a scientific and a practical standpoint.

Made in the beautiful MAHOGANITE or polished black with Dials and Knobs to match.

Sold at all good radio stores or write to us for Catalog.

Look for this stamp on every genuine RADION Panel. Beware of substitutes and imitations.

RADION

The Supreme Insulation

PANELS

AMERICAN HARD RUBBER CO., 11 Mercer St., N. Y.

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"My Manhattan Loud Speaker reproduces musical programs with a rich tone and magnificent feeling that is truly remarkable"

Vincent Lopez

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A twist of the Concert Modulator and the room was flooded with beautiful music.

Of course you know Vincent Lopez. He clicks his baton—his famous Hotel Pennsylvania Orchestra starts—and the whole world dances. Or at least, that part of the world that live near enough to New York to tune-in on his wonderful programs.

No wonder Vincent Lopez is one of the most popular radio artists today. For he is a radio fan himself.

"I must confess" he writes, "that I was never entirely satisfied with musical reception until I heard the Manhattan Loud Speaker. Its rich tone and magnificent feeling are truly remarkable. It reproduces musical programs with a quality and feeling that is not only rare but extraordinary. Moreover, I consider the Manhattan Concert Modulator an important step forward. A slight turn of this Modulator floods the room with beautiful music that is entirely free from distortion or chattering. This really is an achievement that every Radio Fan will appreciate."

Surely you will want the Loud Speaker that Vincent Lopez selected above all others for his own Radio set. Go to your nearest dealer and insist upon a Manhattan, "the Loud Speaker with the Concert Modulator."

Manhattan Electrical Supply Co., Inc.
17 Park Place, New York
Makers of the famous Red Seal Dry Battery
New York Chicago St. Louis San Francisco

MANHATTAN
"The Loud Speaker with the Concert Modulator"

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The CLEAR Loud Speaker!

HOW near the music sounds when it comes through the clear Herald! Just as if you were dining in a famous restaurant, and its orchestra were playing beside you.

That's the effect the Herald always gives. *Absolute clearness.* Because it is free from all blast and blurr. Whether the number be music, lecture or news, the clear Herald is faithful to the performer.

THE Herald, like other good musical instruments, improves with age because of its laminated core, mica diaphragm and permanent magnet. It stands up under power without rattling. The adjustable diaphragm makes it possible to get the most out of a weak set. Height 30 inches. 6-foot cord. Price $30. Slightly more on Pacific Coast and in Canada. Write for folder and enclose your dealer's name.

Herald Electric Co., Inc., 113 Fourth Avenue, New York

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Pathé

PHUSIFORMER

Type "P"

Price $8.50

THIS latest development in the radio field meets the following requirements necessary in building an ideal receiver.

Non-oscillation.
Non-reradiation and non-interference.
Sensitive to distance stations.
Freedom from hand capacity.
Synchronized and calibrated tuning.
Simple operation and construction.
Highly selective.
Inexpensive.
Wave Trap.

(Phusiformer is derived from the Greek word Phusikos, meaning "Natural.")

Jobbers and dealers—watch for national and local advertising and publicity on Phusiformer type "P." Several territories still open for live jobbers and dealers.

PATHE PHONOGRAPH AND RADIO CORP.
20 GRAND AVENUE :: BROOKLYN, N. Y.
WESTERN SALES OFFICE: 533 SOUTH WABASH AVENUE, CHICAGO, ILL.

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Imported PHONES

give you a *new* radio set!

A PAIR of N & K Phones on your old radio set work a complete transformation. They make it sound new and different. Never before have high or low tones, loud or soft tones, come in so *clear*, so mellow, so natural, so free from distortion.

N & K was designed by one of the world's foremost makers of telephone and other scientific apparatus. It was designed especially for *telephone* reception, whereas most radio phones in use today were originally designed to receive *telegraphic spark signals*. The diaphragm is larger and more sensitive, and is placed at a carefully measured distance from the poles. Even the sound chamber is different.

Last year this head set was submitted to hundreds of American amateur radio stations. 90% of these declared it the best head set they ever used.

Famous for comfort

Every user of N & K Phones comments immediately on their comfort and the way they exclude outside sounds. This is due to two things—the extra size of the phones, covering the ear completely, and the leather-covered head bands—which have an additional sanitary value.

You shall be the sole judge

N & K Phones are sold by leading radio dealers everywhere. They are sold with the understanding that your money will be cheerfully refunded if you do not find that N & K Phones reproduce more naturally, give clearer, mellower tone, and fit more comfortably than any other head set.

N & K Head Set, Model D, 4000 ohms. Nickeled brass casing, leather-covered head bands, 6-ft. cord. Retail, $8.50

Dealers, read this!

We authorize you to refund the money on any N & K Phones returned after the above test. We will exchange or replace any that come back to you. Pending the announcement of jobber distributors, we will fill orders direct so that dealers may be prepared for the increasing demand for N & K Phones. N & K comes packed ten to the carton, each carton containing a supply of display matter and literature. Wire or write your order today to department P3.

TH. GOLDSCHMIDT CORPORATION, Distributors, 15 WILLIAM STREET, NEW YORK CITY

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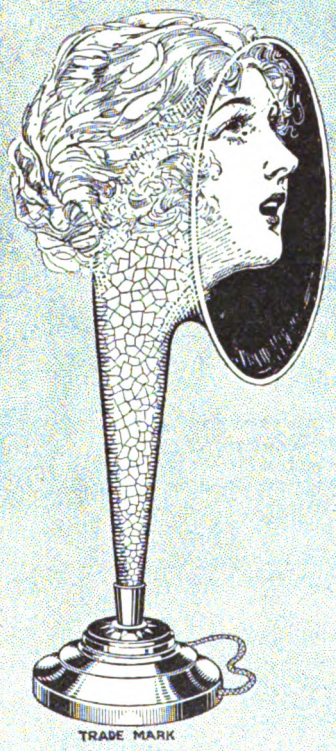
Atlas
TRADE MARK



RADIO-REPRODUCTION LOUD SPEAKER

MUSIC AND SPEECH REBORN

EVERYWHERE acclaimed the most satisfactory radio reproducer. Your own ears will reveal this superiority.

At all Good Dealers Complete..... **$25**

Write for Booklet

Atlas Loud Speaker Unit

With phonograph attachment....$13.50
Without phonograph attachment.$12.50

Sole Canadian Distributors
Marconi Wireless Co., of Canada, Ltd.,
Montreal, Canada.

Multiple Electric Products Co. Inc.

Makers of MONO—TIME-LAG FUSES—MULTIPLE
2 ORANGE STREET **NEWARK, N. J.**
DISTRICT OFFICES AT
CHICAGO, BALTIMORE, PHILADELPHIA, BOSTON, PITTSBURG, ATLANTA, DETROIT, CHARLESTON, KANSAS CITY, ST. LOUIS, LOUISVILLE

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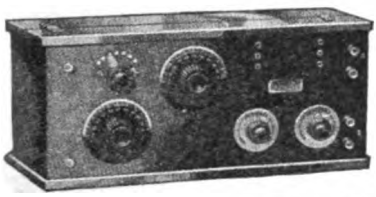

E·D·Elliott of Milford, N.Y. establishes a record

Think of getting London, England, Fairbanks, Alaska, and La Palma, Panama, when you live in New York! Yet this is the experience of Mr. Elliott, one of the hundreds of enthusiastic users of MIRACO sets. With the inexpensive outfit shown here, priced at **only $29.50**, he received the following list of stations—*results that would do credit to a set costing three or four times as much.*

	London, England	WHAY	Wilmington
WLAY	Fairbanks, Alaska	WRAY	Scranton, Pa.
NNW	La Palma, Panama	WOAY	Birmingham
PWY	Havana, Cuba	WSB	Atlanta, Ga.
CFAC	Calgary, Can.	WMU	Washington
CJCY	Calgary, Can.	WCAT	Rapid City
KFBC	San Diego, Cal.	WRC	Washington
KSL	San Francisco, Cal.	KYW	Chicago
KHQ	Seattle, Wash.	KFCB	Phoenix
WJAR	Providence, R. I.	WWT	Buffalo, N. Y.
KFBU	Lorine, Wyo.	WHAS	Louisville, Ky.
WEV	Houston, Tex.	WCAY	Milwaukee, Wis.
WMAT	Duluth, Minn.	WLW	Cincinnati, O.
WPM	Washington	WDAW	Omaha, Neb.
WRAA	Houston, Tex.	WOQ	Kansas City
WHB	Kansas, Neb.	WPAW	Wilmington
KFHB	Hood River, Ore.	WCE	Minneapolis
CFCA	Toronto, Can.	WCX	Detroit, Mich.
CKCE	Toronto, Can.	WLAZ	Warren, O.
CJCI	St. John, Can.	WAAS	Decatur, Ga.
WRP	Dallas, Tex.	WTAM	Cleveland, O.
NGE	Miami, Fla.	WWJ	Detroit, Mich.
KGA	Oakland, Cal.	WJAZ	Chicago, Ill.
KFEL	Denver, Colo.	WDAP	Chicago, Ill.
WIAZ	Miami, Fla.	WGY	Schenectady, N. Y.
WKY	Oklahoma City	WJZ	New York City
WDAE	Tampa, Fla.	WEAF	New York City
WEB	St. Louis	WOR	Newark, N. J.
WRK	Hamilton	WHAS	Louisville, Ky.
WHAB	Galveston, Tex.	WEAB	Dodge, La.
6ZV	Salt Lake City	WKD	Gainville, Ga.
NAA	Arlington Va.	WUQ	Washington, D. C.
WJAX	Cleveland, O.	KMO	Tacoma, Wash.
WBZ	Springfield	KOB	New Mexico
WOO	Philadelphia, Pa.	WDAR	Philadelphia, Pa.
WOS	Jefferson City, Mo.	WFI	Philadelphia, Pa.
WOK	Pine Bluff, Ark.	WIP	Philadelphia, Pa.
WLAG	Minneapolis	KDKA	Pittsburg, Pa.
WFAZ	Charleston	WCAE	Pittsburg, Pa.
WJAB	Lincoln, Neb.	KMN	Butte, Mont.
WCT	Chicago	KQP	Hood River, Ore.
WMC	Memphis	WHAZ	Troy, N. Y.
WBAK	Harrisburg	WGR	Buffalo, N. Y.
WLAK	Bellow Falls, Vt.	WMAV	Auburn, Ala.
WBAN	Paterson, N. J.	KFDD	Boise, Ida.
WOC	Davenport	WNAL	Omaha, Neb.
WPAP	Winchester, Ky.	WCAP	Washington, D. C.
WMAM	Beaumont, Tex.	WQAB	Springfield, Mo.
WWZ	New York	WFB	St. Louis, Mo.
WBAY	New York	WDR	Detroit, Mich.
WGL	Philadelphia, Pa.	WNAC	Boston, Mass.
WMAF	Dartmouth, Mass.	WBAZ	Columbus, O.
WBAG	Bridgeport	CFZC	Montreal, Que.
WCAP	Decatur	WMAK	Lockport, N. Y.
WHN	Ridgewood	WGF	Des Moines, Ia.
WIAR	Paducah	WHAM	Rochester, N. Y.
WRP	Camden, N. Y.	WCAM	Villa Nova, Pa.
WGAR	Fort Smith, Ark.	WGAY	Madison, Wis.
WDAK	Hartford, Mass.	WWI	Dearborn, Mich
WCAG	New Orleans	WGAM	Orangeburg, S. C.
	WWAJ	Columbus, O.	

Radio's finest low-priced receivers

Here, in the improved MIRACOS, you'll find the same thrill of getting long distances, generally obtainable with only the most expensive and elaborate sets. To the whole family it will furnish entertainment, **unfailingly**, the whole year round—and at an initial price most every family can afford.

It isn't necessary, either, to be an expert at tuning in with the MIRACO. The operation is extremely simple. Scores of users everywhere tell us of the long-distance records they're making—Cincinnati hears 'Frisco, Denver hears Schenectady, New York hears Havana!

Such range as this is made possible through MIRACO'S many new refinements. Improved rheostats with multiple resistance windings enable you to use any type of tube, and a new aluminum shield prevents annoying body capacity effects. Shock absorbing pads prevent tube noises. Fully GUARANTEED against defects in material or workmanship. Price for 4-tube outfit shown above only **$54.50.**

Other details of MIRACO receivers are explained more fully in our new bulletin. Write today for a copy.

THE MIDWEST RADIO COMPANY
812 Main Street, Cincinnati, Ohio

The Improved MIRACO

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You wouldn't think it was the same set since I've added "All American" Power Amplification

For an astounding roundness, richness, depth and clarity of tone —*plus maximum* volume wholly without distortion!—just hook up a pair of All-American Power Amplifying Transformers in a "push pull" circuit and add it to your present audio frequency amplifiers.

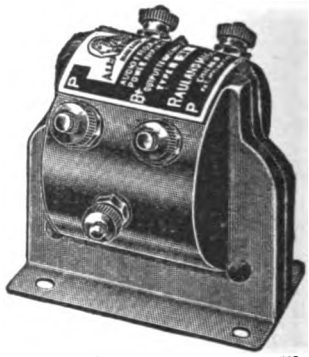
Use any good loud speaker—you'll be delighted beyond words.

"Absolutely the most efficient, most satisfactory 'push-pull' transformers ever put on the market"—this is the verdict of radio enthusiasts everywhere.

All-American Power Amplifiers are as popular as All-American Audio and Radio Frequency Transformers—which is the highest compliment that could be paid them because the latter are the best-liked, most widely used transformers in the world.

SPECIAL OFFER

Send for the new "All-American" diagram and circular describing Power Amplification; also Book of 22 Tested Hook-ups for getting new thrills out of your radio equipment. Send 4c in stamps.



For "Push-Pull" Circuits: The All-American Power Amplifying Transformers Input and Output types $6.00 each.

All-American Audio Frequency Transformers lead in sales: 3:1, 5:1, 10:1, $4.50 to $4.75. The best —no need to pay more.

Watch for the new All-American Long Wave Radio Frequency Transformer suitable for Super-Heterodyne Circuits.

Rauland Mfg. Co., 200 N. Jefferson St., Chicago

(Pioneers in the Industry)

Audio and Radio Frequency; Power Amplifying (input and output)

ALL-AMERICAN

AMPLIFYING TRANSFORMERS

Largest Selling Transformers in the World

OVER 500,000 IN USE! ALL THE BETTER DEALERS SELL ALL-AMERICAN

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AMPLION

The World's Standard Loud Speaker

You Never Tire of the Amplion

THE most striking thing about the Amplion is that its reproduction is never tiring. Its perfect rendition, absence of harshness gives you a thrill that is pleasing and refreshing.

No matter if it's voice or instrument, the charm is there. The message has lost nothing in its flight through space. It holds you and enthralls you just as if you were listening to the original.

The Amplion is made in several sizes to suit all occasions and pocket books from $18 for the Junior model to $66 for the Concert type

Ask your dealers to let you hear the Amplion. You owe it to yourself to hear the world's standard loud speaker before you buy.

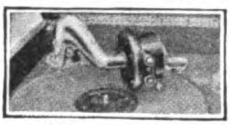
Folder of styles and prices on request.

Patentees:
Alfred Graham & Company

Signal Electric Mfg. Co.
Sole U. S. Distributors Menominee, Mich.

BURNDEPT OF CANADA, Ltd.
Canadian Distributors
172 King Street, W., Toronto

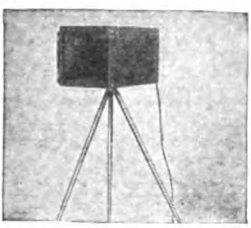
Amplion Beauty AR-15
$46.00



Phonograph Unit AR-35—$24.00

Amplion Dragon AR-19
$40.00

Amplion Junior DeLuxe AR-45
$26.00



Amplion Portable AR-61—$50.00

Amplion Jnnior AR-39
$18.00

The Supremacy of the AMPLION is the Supremacy of Actual Performance

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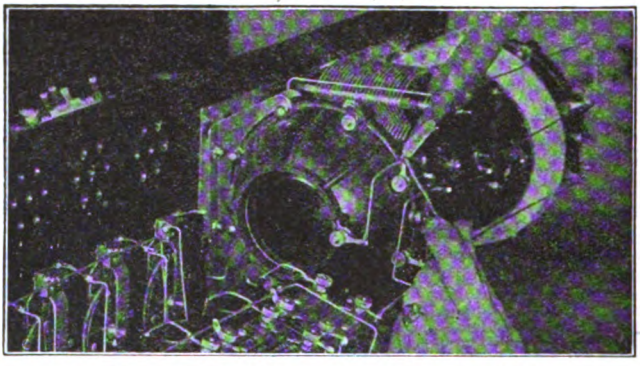
KELLOGG RADIO PARTS

Easy { to Mount / to Wire / to Solder / to Tune



No Fussing or Re-drilling—Just Mount and Solder

They furnish every convenience for quick efficient assembly. And when connected—"O Boy!"

Did you ever hear such volume and still so clear and distinct!

That is the satisfaction of using Kellogg radio equipment—it puts the 'Ray' in Radio.

Join the group of "Happy Radio Fans." They are strong believers in quality, and Kellogg apparatus.

USE—is the test

KELLOGG SWITCHBOARD & SUPPLY COMPANY

1066 West Adams Street, Chicago

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Eagle Neutrodyne

Balanced!

RADIO RECEIVER

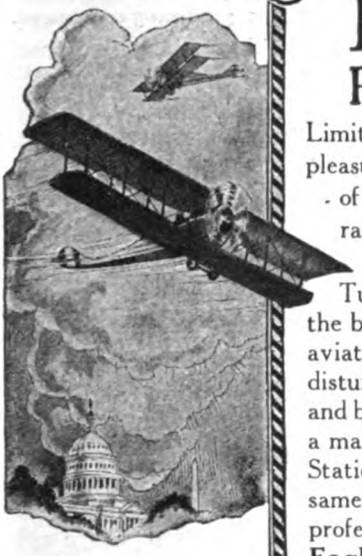
Limitations removed—new possibilities, new pleasures made available for a larger circle of radio enthusiasts—by this marvelous radio receiver.

***

Tube capacities, in balance as perfect as the balance of the gyroscope upon which the aviators' life depends. Clears reception of disturbances from regeneration, reradiation and body capacity effects. Tuning, no longer a matter of guessing, but positively precise. Stations once located, always found at the same point on the dial. Operation of this professional's circuit made as simple in the **Eagle Neutrodyne Receiver** as the use of a phonograph. Each **Eagle receiver** balanced—(tube capacities neutralized) **individually,** by foremost radio experts. Sponsored by a well reputed manufacturer. Guaranteed without reservations.

***

Licensed by Independent Radio Manufacturers, Inc., under Hazeltine Patent No. 1,450,080. Dated March 27th, 1923, and other patents pending.



BALANCED AS PERFECTLY AS THE GYROSCOPE BALANCES THE AEROPLANE

Write for Illustrated Leaflet

WE SOAR ABOVE

EAGLE RADIO COMPANY

NEWARK NEW JERSEY

18 Boyden Place

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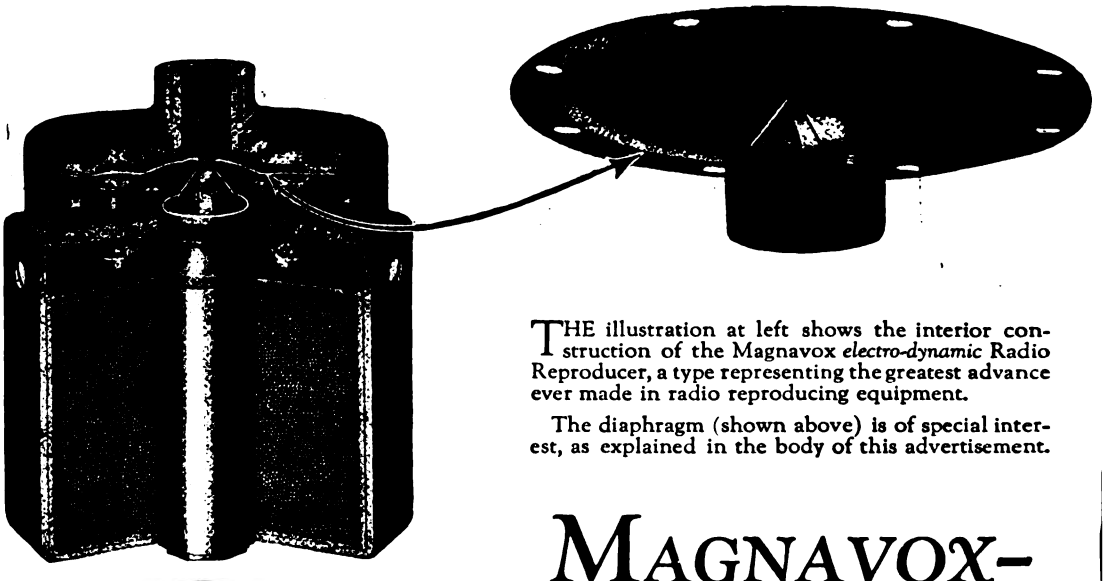

THE illustration at left shows the interior construction of the Magnavox *electro-dynamic* Radio Reproducer, a type representing the greatest advance ever made in radio reproducing equipment.

The diaphragm (shown above) is of special interest, as explained in the body of this advertisement.

MAGNAVOX-

The true Radio Reproducer

THE basis of the operation of a Magnavox Reproducer is its diaphragm, the importance of which can be seen from the fact that it is required to render an almost human service in recreating every tone and quality of instrumental music as well as speech.

This diaphragm (as illustrated above) has been designed and constructed in accordance with entirely new principles. Its shape, size and special character make it capable of responding to the widest range of tones.

But even this highly efficient diaphragm might be handicapped by operating restrictions—every diaphragm must have a vibrating force applied to it, and the inherent ability of any diaphragm will be injured if it is affected by mechanical operation or other foreign influences.

The use of the electro-dynamic principle of operation (found only in Magnavox Reproducers) removes all objectionable influences. This principle, utilizing the famous "movable coil" permits the Magnavox diaphragm to respond in perfect unison to the original tone.

A1-R—$59.00

This instrument (Magnavox Combination Set) consists of Magnavox electro-dynamic Reproducer combined with a Magnavox Power Amplifier in one unit.

There is a Magnavox for every receiving set: Type R for storage battery sets, and M1 for dry battery sets.

THE MAGNAVOX COMPANY

Oakland, California

***New York Office:* 370 SEVENTH AVENUE**

PERKINS ELECTRIC LIMITED, Canadian Distributors
Toronto, Montreal, Winnipeg

3R

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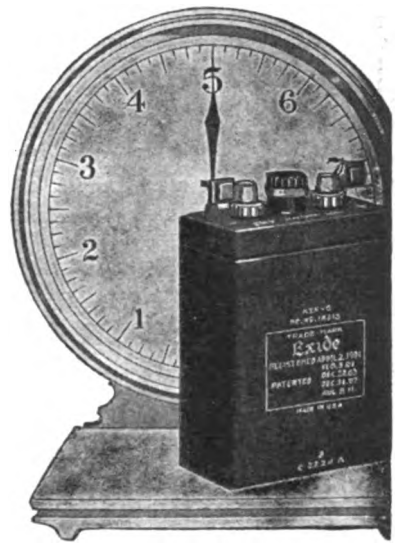
To get best results with low-voltage tubes



This 2-volt A Exide Storage Battery weighs only five pounds

FOR perfect clearness you must use a storage battery with uniform current. This is particularly true if you are a fan for long distance. When signals are weak the steadiness of a dependable A storage battery is indispensable to good receiving.

There are two tiny but sturdy Exide A Batteries designed specially for WD-11 and UV-199 vacuum tubes, and they give fine service with any low-voltage tubes.

You can carry one of these little batteries in the palm of your hand, yet they are powerful enough for long-distance receiving and have the true Exide ruggedness built into them.

A battery for 6-volt tubes

Three sizes of A batteries

The 2-volt battery has a single cell and weighs five pounds. It will heat the filament of a WD11 or other quarter-ampere tube for approximately 96 hours. The 4-volt battery has two cells, weighs six pounds and will light the filament of a UV-199 tube for 200 hours.

A battery with a pedigree

The Exide A Battery for 6-volt tubes is made in four sizes, of 25, 50, 100 and 150 ampere-hour capacities. These batteries have extra-heavy plates, assuring constant voltage and uniform current over a long period of discharge.

A good storage battery does not just happen. It is the result of long experience. The skill acquired and the resources developed in making batteries for every purpose since the beginning of the storage battery industry thirty-five years ago are built into the Exide Batteries made specially for your radio.

Wherever batteries *must* be reliable—such as on submarines, in the telephone system, in firing the guns of our battleships, in the central power stations of our great cities—there you will find Exides doing their unfailing duty. A majority of all government and commercial radio plants are equipped with Exide Batteries.

Exide Radio Batteries are sold by radio dealers and Exide Service Stations everywhere. Ask the dealer, or write direct to us, for booklets describing the complete line of Exide Radio Batteries.

Exide
RADIO BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

Manufactured in Canada by Exide Batteries of Canada, Limited, 133-157 Dufferin Street, Toronto

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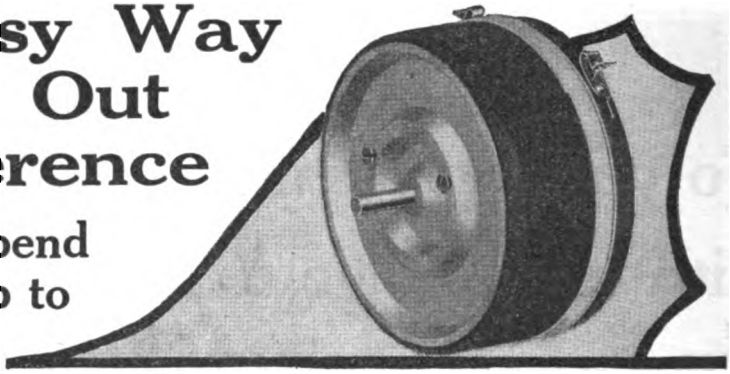
An Easy Way to Cut Out Interference

Add a Ferbend Wave Trap to Your Set



Enjoy your radio set. Get the station you want, *quickly*. Listen in on one thing at a time without annoying squawk-k-k-s or irritating whistles.

The Ferbend Wave Trap Makes Every Night Silent Night

New radio broadcasting stations are making receiving constantly more difficult. Many owners of long-distance sets are discovering powerful amplification is of little value so long as local stations are "all over the dial." Hundreds of users have solved the difficulty with the Ferbend Wave Trap—the missing link in Radio. A St. Louis user reports: "Heard Havana clearly with three St. Louis stations broadcasting. My receiver works like a new set. The 'Ferbend' is certainly a wonder!"

YOU Can Obtain These Remarkable Results

You can obtain results as satisfactory as this St. Louis user. If you don't, it doesn't cost you a penny for the "Wave Trap" is sold with a positive guarantee that it will tune out your powerful local stations. Don't wait. Order now at our risk.

SEND NO MONEY

You need not send a penny. Pay Postman $6.00 (plus postage). If you prefer, send $6.00 with order and Wave Trap is mailed *postpaid* ready for panel mounting. Money back guarantee either way. You see you take no risk, so order TODAY.

FERBEND ELECTRIC CO.

21 E. South Water St. Chicago

Ferbend Electric Co.
21 E. South Water St., Chicago

Send me a Ferbend Wave Trap. I will pay Postman Special low price plus postage. I understand you guarantee Wave Trap to tune out interfering stations or refund money.

☐ Check here for Ferbend Wave Trap unmounted at $6.00. ☐ Check here for Ferbend Wave Trap mounted at $8.50

Either way, the Ferbend comes to you completely guaranteed.

Name .....

Address .....

City ..... State .....

FERBEND

TRADE Wave Trap MARK

PATENT APPLIED FOR

The Original Wave Filter

The Ferbend Wave Trap can also be supplied completely mounted ready for instant use on formica panel in mahogany finished cabinet, 6 x 5 x 6, $8.50. Get full benefit of all the distance your set will give you. Order your Ferbend TODAY.

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The Whole Family "Listens In"

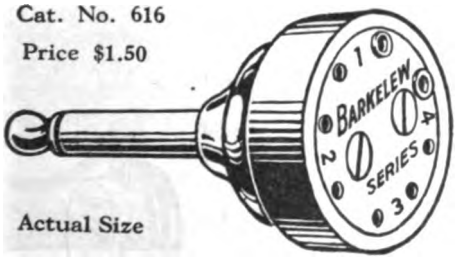
It makes a happy family group, when Dad, Mother and the children can "listen in."

The Barkelew Four Phone Plug makes this possible.

With this plug, 4 persons can enjoy the Radio Program from your set, as clearly and distinctly as one. There is ample room for all the phone tips, and they can be adjusted without removing the plug.

Barkelew Four Phone Plug

Cat. No. 616
Price $1.50



Actual Size

Connects one to four head sets all *in series* to any radio set employing standard telephone jacks. Improvements in the 1924 model make it the most reliable buy on the radio market.

CHICAGO, ILL.

BARKELEW

ELECTRIC MANUFACTURING CO.
MIDDLETOWN, —— OHIO.

SAN FRANCISCO.
75 FREMONT ST.

LOS ANGELES
411 S. MAIN ST.

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THE SIEGE OF TROY

AT the dawn of civilization the signal fire was the principal means of conveying information over distances.

During the ten-year siege of ancient Troy, the Greeks under Agamemnon by this means maintained constant communication throughout their encircling camps.

Today there has been developed a series of instruments that enable us to communicate and even protect our actual personalities over vast distances.

Of all the instruments that make Radio possible none is more important than the Headphones or Loud Speakers. These transform into sound the delicate electric currents produced in your receiving set. If they are imperfect the results are unsatisfactory.

HOLTZER-CABOT Headphones and Loud Speakers embody the latest developments in the art and will greatly increase your enjoyment of Radio.

Holtzer-Cabot Loud Speaker	**$25.00**
Loud Speaker Phonograph Attachment	**10.00**
No. 2 Universal Headphones	9.50
No. 4 National Headphones	6.00

Write for booklets explaining how the exclusive features of these instruments enable you to enjoy the wonders of Radio

THE HOLTZER-CABOT ELECTRIC CO.
125 Amory Street, Boston, Mass.
6161-65 South State Street, Chicago, Ill.
Department B

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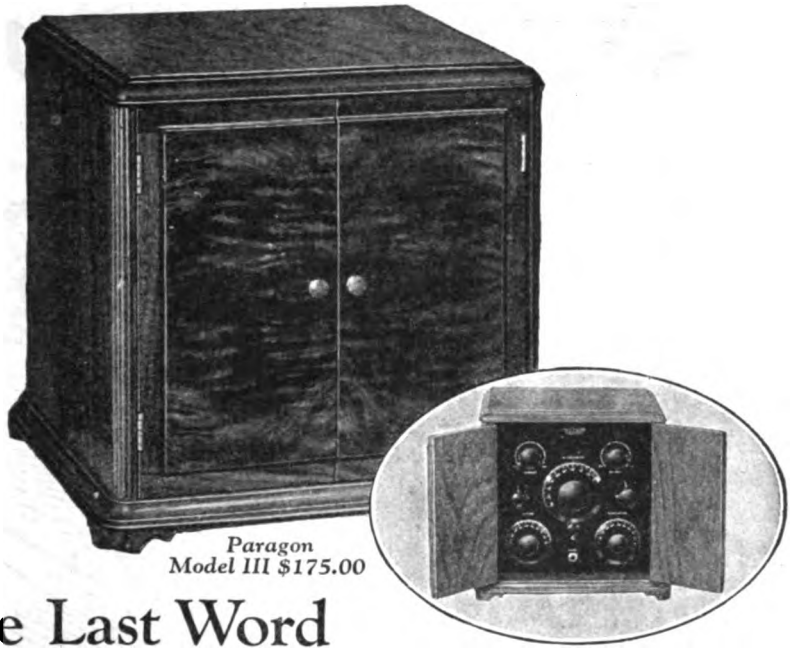

Paragon
Model III $175.00

The Last Word
In a Paragon Receiver for the Home

At last—a radio set that not only harmonizes with your furniture but adds to the attractiveness of any room in which it is placed. And not an ordinary radio set but a PARAGON.

Paragon Receivers are famous for the long distance records they hold which include the reception of the first trans-continental amateur message and the first trans-Atlantic message. It is a Paragon that keeps the world in touch with the MacMillan Expedition, frozen in north of Greenland.

Paragon Receivers, because of their superior selectivity and sensitivity, are equally famous for the ease with which they can be operated and the clear results obtainable.

The Model III, pictured above, has all the advantages of the other models but is housed in a mahogany or burled walnut cabinet which is a work of art.

In appearance, the Paragon Model III Receiver now matches up in every way to the perfection of the instrument itself.

Write for illustrated catalog of Paragon Radio Parts

Dealers: **We believe in the proper distribution of Paragon Radio Products. Our Exclusive Distributors are particularly interested in territorially protected dealers, who will concentrate, solicit and serve the consumer in the sale of Paragon Radio Receivers. If interested, write us for details.**

ADAMS-MORGAN CO., 20 Alvin Avenue, Upper Montclair, N. J.

PARAGON

Reg. U. S. Pat. Off.

3-CIRCUIT RECEIVER

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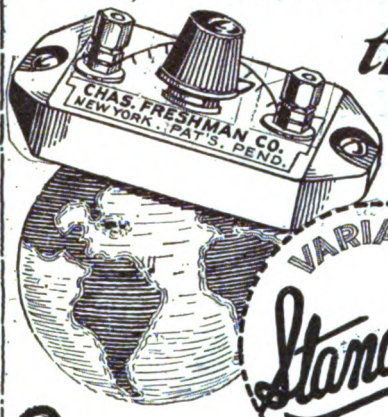
The Stamp of Approval the World Over



VARIABLE *Standard* GRID LEAK

FRESHMAN Variable Grid Leak

"The Standard Unit for Every Tube Set"

EVERY tube and every circuit require a different grid leak resistance. The method employed in the Freshman Variable Grid Leak permits you to adjust your circuit to any resistance you wish, from 0 to 10 megohms in an unbroken range of 180 degrees.

The Freshman Variable Grid Leak and Condenser combined, takes the place of a grid condenser, leak mounting and grid leak—and, in addition, permits an adjustment to the correct amount of resistance.

The Freshman Variable Grid Leak is the most compact, the most perfect, the most efficient, the most readily adapted to all grid circuits,—and the only one which is entirely sealed and always remains unaffected by any climatic conditions. It is the

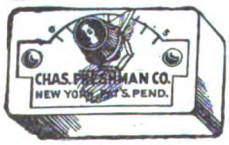
ORIGINAL VARIABLE GRID LEAK

Ask your dealer or write for our free diagrams of Neutrodyne, Tri-Flex, Kaufman and other good circuits.

Either Base or Panel Type Complete with .00025 or .0005 MF. Freshman Condenser... **$1**

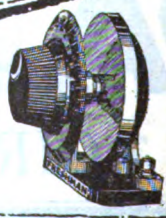
Either type without Condenser.. 75c

At your dealers, otherwise send purchase price and you will be supplied without further charge.



PANEL TYPE VARIABLE GRID LEAK

Chas. Freshman Co. Inc.
Radio Condenser Products
106 SEVENTH AVENUE
NEW YORK CITY



"FRESHMAN SELECTIVE" MERCURY VARIABLE CONDENSER
$5.00

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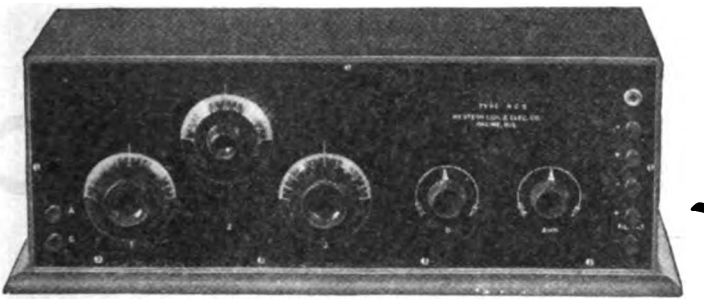

A Special Low Wave Receiving Set

Wave Lengths from 90 to 380 Meters

Are you having trouble getting short wave signals? The WC-5-SW shown above is the most practical set for low wave specialists. Built by short wave experts the WC-5-SW eliminates the trouble which transmitting amateurs are having with ordinary receiving sets. If you are interested in getting better low wave results it will be to your advantage to investigate the WC-5-SW. Enthusiastic operators from all parts of the country write us praising its efficiency.

WC-5-SW

Built Especially for Transmitting Amateurs

The WC-5-SW is a 4-tube set. One stage of tuned Radio-Frequency amplification is employed ahead of the detector to make it super-sensitive. Two stages of audio-frequency are used to bring up the signal strength. Uses any type of tubes. Gives perfect control of audibility. Detector rectifies only. Uses antenna compensating condenser. Only two control adjustments. Pure negative biasing on all tubes, thus marked saving on "B" Battery current. Tuned Radio-Frequency sharpest known and most selective principle ever adopted. Plate potential non-critical. Mono-block tube socket. No grid plate leads on audio amplifiers. Audio amplification absolutely necessary when using low efficiency receiving antenna, i.e., underground or indoor. Mahogany cabinet, piano rub finish. Rabbited-in panel. Split lid cover. The price is only $85.00.

Write for complete description and illustrated folder on this practical set for low wave specialists. All transmitting amateurs will be interested in this literature.

OTT RADIO, Inc.

222 Main Street **La Crosse, Wis.**

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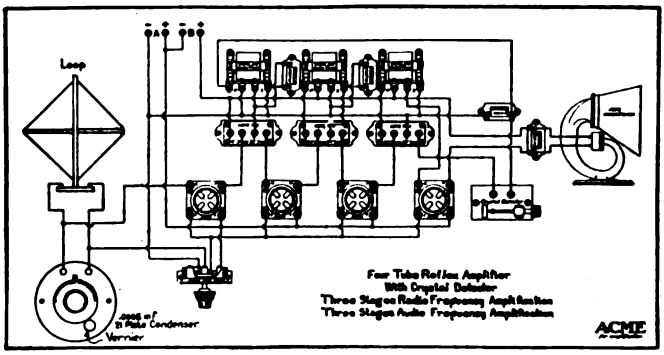
Make your Set "REFLEX" with ACME



The Acme Pot Rheo

. . . "Having tried almost every circuit on the market, I find that there is nothing that will compare with this hook up in any way."

"MY LIST of call letters is too long to mention in this letter. . . . This circuit delivers such volume from points thousands of miles away . . . in fact, it brings in the distant stations just as loud as it does the local and without any distortions" . . . Writes an enthusiastic builder of an Acme Reflex.

This Reflex circuit was perfected by our engineers after eighteen months of testing and experimenting. It gives the best consistent results for the best expenditure, the least construction and tuning effort and the least trouble. It brings in the distant stations loud and clear and it won't annoy your neighbor.

For best results—Follow the diagram closely and use only the best apparatus. One Acme booster writes us: "Acme is so far ahead in every way that we would be foolish to attempt this hook up with any other make of transformer." Write to us for "Amplification without Distortion"—a booklet containing wiring diagrams and helpful points on construction and operation. Use the coupon.

ACME APPARATUS COMPANY
Dept. 41, Cambridge, Mass.

The Acme Radio Frequency Amplifying Transformer R-1, 2, 3, 4 for distance

Acme Kleerspeaker

The Acme Audio Frequency Amplifying Transformer Type A-2

ACME
~ for amplification

ACME APPARATUS COMPANY,
Dept. 41, Cambridge, Mass.

I enclose 10 cents (U. S. stamps or coin) for copy of new edition of "Amplification without Distortion" containing complete instructions and wiring diagrams for making my set "Reflex."

Name .....

Street .....

City ..... State .....

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ONE CONTROL ONLY

Makes It Most Simple to Operate

BRISTOL SINGLE CONTROL RADIO RECEIVER

(Non Regenerative)

Using Grimes Inverse Duplex System

SIMPLICITY OF OPERATION is the outstanding feature of this Receiving Set. One Control Dial includes every adjustment. To tune in, turn this Dial. A station once located can always be brought in again at the same setting.

NOT CONFINED TO LOCAL BROADCASTING—this four-tube set has power equal to six. Because the Grimes Inverse Duplex System utilizes the first two tubes for both Radio and Audio Amplification.

ANTENNA OR LOOP—either may be used to suit conditions.

SOLID MAHOGANY CASE with walnut finish encloses the complete Receiving Set. It is a beautiful piece of furniture fully in keeping with the most luxurious room.

The price—Bristol Single Control Radio Receiver, $190.00.

Ask for copy of Bulletin 3013-L describing this set.

THE BRISTOL COMPANY
Waterbury, Conn.

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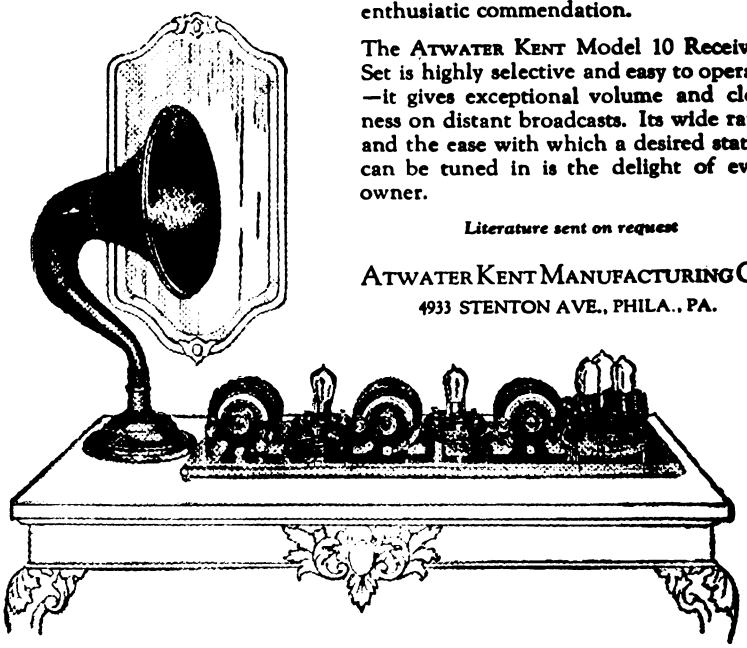
ATWATER KENT

Philadelphia

New Standards in Radio Reception

The clearness with which the ATWATER KENT Loud Speaker re-creates will give you a new conception of tonal fidelity



IN the ATWATER KENT Model 10 Receiving Set and the ATWATER KENT Loud Speaker, new standards of excellence have been attained. No achievements in radio reception during the past year have created quite the same widespread interest and enthusiatic commendation.

The ATWATER KENT Model 10 Receiving Set is highly selective and easy to operate:—it gives exceptional volume and clearness on distant broadcasts. Its wide range and the ease with which a desired station can be tuned in is the delight of every owner.

Literature sent on request

ATWATER KENT MANUFACTURING CO.
4933 STENTON AVE., PHILA., PA.

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This Radio Catalogue FREE

Save 1/3 on Guaranteed Radio Equipment

Write us a post card—

Address Dept. 38-R

and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete tube set having a range of 500 miles and more, including tube, head set, batteries, and antenna equipment, as low as $23.50.

This catalogue contains everything for the expert and amateur. Complete sets and every improved part for building sets, all the most up-to-date devices—at the lowest possible prices.

Headquarters for Radio

Montgomery Ward & Co. is headquarters for Radio, selling everything direct by mail without the usual "Radio-profits." Why pay higher prices? Ward quality is the best and the prices will often save you one-third. Everything sold under our Fifty Year Old Guarantee—Your Money Back if You Are Not Satisfied. Write today for your copy of this complete 52-page Radio Book.

Write to our house nearest you
Address Dept. 38-R

Chicago Kansas City Ft. Worth St. Paul Oakland, Cal. Portland, Ore.

Established 1872

Montgomery Ward & Co.

The Oldest Mail Order House is Today the Most Progressive

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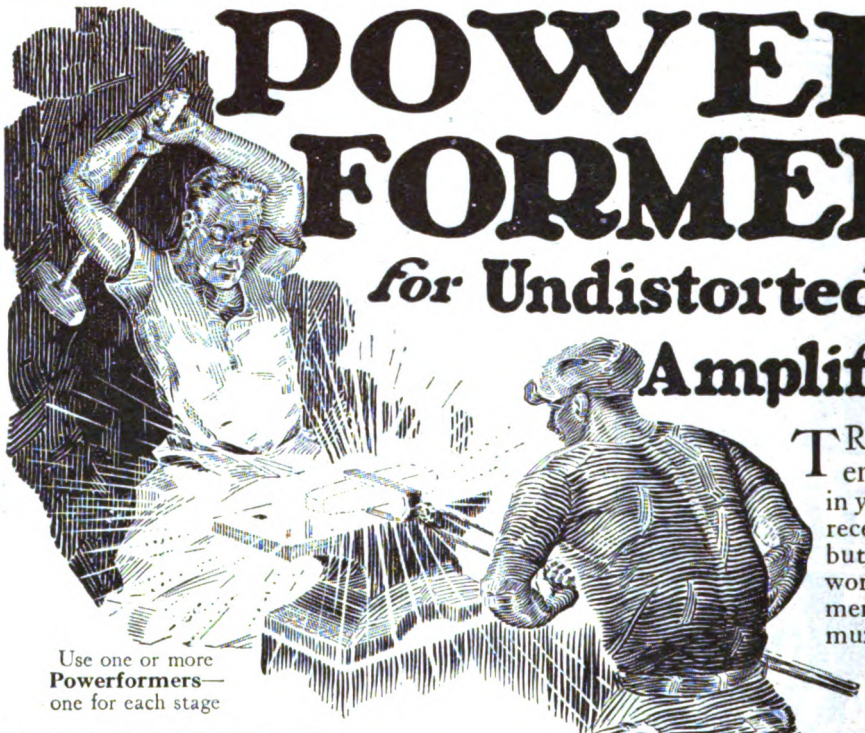
POWER-FORMERS

for Undistorted Amplification

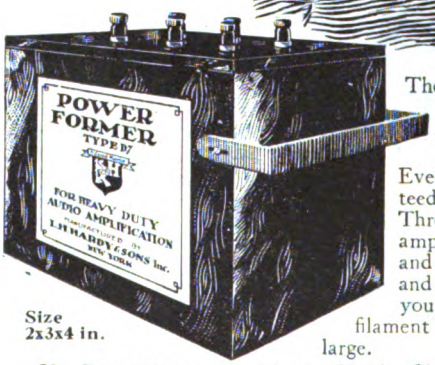


Use one or more **Powerformers**— one for each stage

TREMENDOUS energy lies latent in your vacuum tube receiver if you will but put the tubes to work. Instead of mere whispers and muffled orchestrations you will be electrified with the pure, full tone of distant stations when using **Powerformers.**

The **Powerformer** absolutely refuses to distort and at the same time amplifies beyond your weirdest expectations.

Every **Powerformer** is guaranteed to give successful results. Three stages of **Powerformer** amplification will astound you and your friends with their clarity and volume. On local programs you will be forced to reduce your filament unless the room is unusually large.



Size 2x3x4 in.

THE Hardy Powerformer is an impedance balancing device which forces the vacuum tube to amplify to the extreme limit of its *constant*. It is therefore 100% efficient as a coupler. Furthermore, it does not cause or permit distortion.

Hitherto, the great difficulty in audio frequency amplification has been due to the inherent inefficiency of magnetic, iron-core transformers. Such couplers have high losses, do not afford a properly balanced load on either of the tubes between which energy is being transferred and they introduce serious distortion no matter how cleverly designed.

The Hardy Powerformer performs efficiently regardless of the tuning circuit. Powerformers are adaptable to all standard vacuum tubes.

Prices

Powerformer, Type D-7	$5.50
Toro-Tran, Type R-7 (200-600 meters)	5.00
Toro-Tran, Type R-8 (3,300 meters)	9.50
Inductometer, Type R-9	3.50
Inductometer, Type 5-K	8.50
Inductometer, Type X-4	35.00
Ultimate Receiver	500.00

Use **Powerformers** with the Hardy Circuit **Inductometer** for long distance results and precision tuning. For Tuned and Nullified Radio Frequency, as well as for Super-Heterodynes, specify Hardy **Toro-Trans,** using **Powerformers** for audio amplification.

THE HARDY ULTIMATE RECEIVER

THE Hardy **Ultimate Receiver** is a console type receiving set which is sold complete with all accessories. It is built into a period table cabinet of unusual taste and ornamental value. Each instrument is custom built, for specific service and is fully guaranteed under written specifications.

Write for Brochure: "HARDY RADIO DEVICES."

A Good Name

HARDY MANUFACTURING CO.

130 EAST 55th ST. NEW YORK CITY

Please refer to POPULAR RADIO *when answering advertisements.*

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Cockaday specifies the Bradleyleak

Improved 4-Circuit Tuner Needs Bradleyleak for perfect operation of detector tube

ANOTHER Prominent Radio Engineer has recognized the unusual performance of the Bradleyleak! In a recent article in Popular Radio, Mr. Laurence M. Cockaday, inventor of the Cockaday circuit, specifies the Bradleyleak as an essential part of his tuner which produces such wonderful results. Many other radio experts such as Kennedy, Crosley, Amrad and Flewelling endorse the Bradleyleak as a distinct achievement in grid leak construction. Amrad has just adopted the Bradleyleak for the expensive Console and table sets.

THERE are very definite reasons for the success of the Bradleyleak. It is unaffected by moisture or atmospheric conditions and has a guaranteed range of stepless control from ¼ to 10 megohms. The grid circuit is extremely sensitive and a poor grid leak can cripple the action of the finest tube.

Try a Bradleyleak tonight and be assured that your grid circuit will remain permanently adjusted for long range reception.

Is Your Grid Leak Correct?

The following table gives the approximate values of grid leak resistance recommended by vaccum tube manufacturers:

Audion (De Forest) DV-6	2 Megohms
C-200	2 Megohms
C-299	2 to 5 Megohms
C-301-A	2 Megohms
UV-199	2 to 5 Megohms
UV-200	2 Megohms
UV-201-A	2 Megohms
WD-11	3 Megohms, or more
WD-12	3 Megohms, or more

Allen-Bradley Co.
Electric Controlling Apparatus

276 Greenfield Ave. A-B Milwaukee, Wisconsin

Manufacturers of graphite compression rheostats for over 20 years.

Mail This Coupon—Today!

ALLEN-BRADLEY CO.
276 Greenfield Ave., Milwaukee, Wis.

Please send me your folder describing the Bradleyleak and its construction.

Name.....

Address.....

.....

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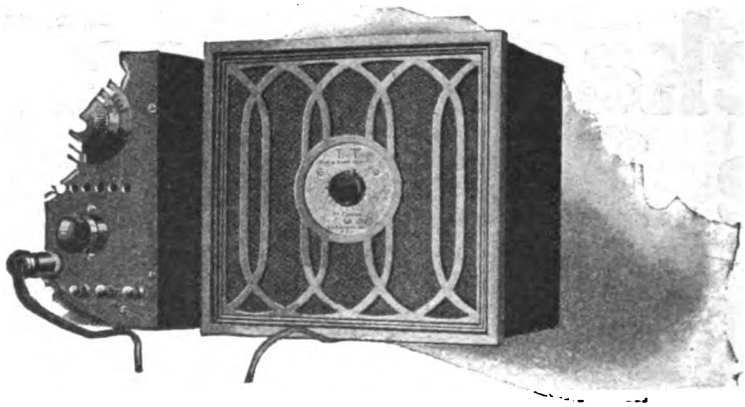
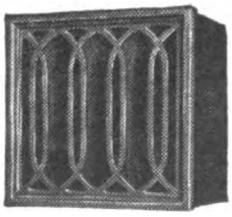


Why You Should Purchase a Cabinet Type Radio Loud Speaker

If you remember, as the phonograph developed into a piece of fine furniture all horns disappeared, until today a phonograph with an exposed horn is completely out of date.

The horn is there it's true, but as in the Timmons Talker it is hidden in the cabinet behind the scroll and screen.



Type N—$25; the other, Type A, is $35

As a matter of fact there are two horns in Timmons Talkers—the wonderful principle of reflected tone is employed. This means that all sounds and musical notes, high and low, are rendered round and full and absolutely without distortion.

There are really 16 features of Timmons Talkers which you should know about. We'll send a large detail illustration, also our folder "Volume without Noise."

Your dealer has both types of Timmons Talkers, **A** (adjustable) $35.—N (non-adjustable) $25

J. S. TIMMONS

339 East Tulpehocken Street

GERMANTOWN, PHILADELPHIA, PA.

TIMMONS TALKERS

Please refer to POPULAR RADIO *when answering advertisements.*

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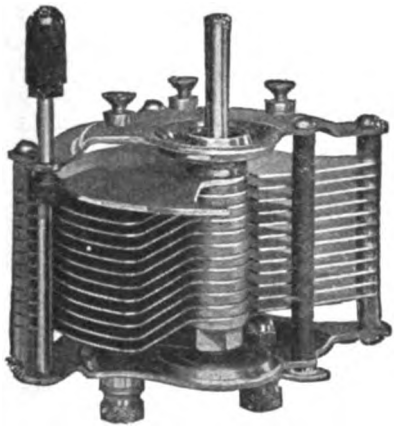
A Standard of Condenser Excellence
—note the points of proven Superiority!!

5 POINTS

1. Stator plates pressed into slots, assuring perfect electrical contact.
2. Proper capacities, and no over-rating of same.
3. Rigid construction, so original adjustment is maintained.
4. Rotor and stator plates of logarithmic curve type.
5. Formica insulation throughout.



5 MORE!

1. Patented vernier arrangement, eliminating body capacity.
2. Special spring aluminum plates.
3. Lowest dielectric losses, proven by laboratory tests.
4. Special friction bearing on rotor shaft.
5. Independent vernier control. Vernier does not rotate with main rotor plates.

A radio receiving set is no better than its variable condensers!

STRAIGHTLINE
TRADE MARK

V A R I A B L E
VERNIER CONDENSER

Upon the condensers used depends the efficiency of your set. Buy only the best! You can pay a higher price—but cannot get a better condenser than STRAIGHTLINE

Type G 13 Pl. .0002 mfd. **3.00** Type H, 23 Pl. .0005 mfd. **3.50** Type J, 43 Pl. .001 mfd. **4.00**

A Product of **HAIG & HAIG** Manufacturing Co.
ROCHESTER, NEW YORK

If your dealer has none send his name with your remittance direct to

RADIO STORES CORPORATION
Sole International Distributors
NEW YORK—CHICAGO—MINNEAPOLIS—LOS ANGELES—
CLEVELAND — ST. LOUIS — OMAHA — SAN FRANCISCO.
HOME OFFICE, 220 West 34th Street, NEW YORK, N. Y.

—insist on STRAIGHTLINE

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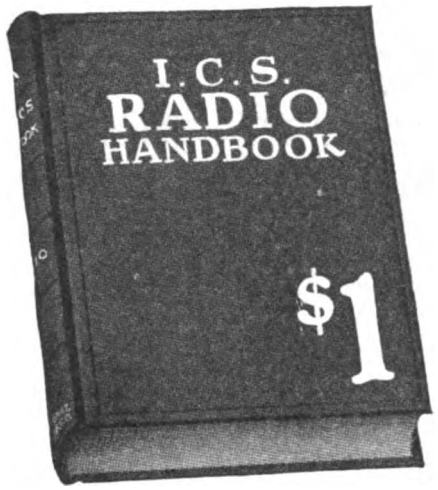


At last! A practical authoritative book on

RADIO

562 pages. Price only $1

Compiled by **HARRY F. DART, B.S., E.E.**
Formerly with the Western Electric Co., and U. S. Army Instructor of Radio
Technically edited by **F. H. DOANE**

THE most complete book of its kind ever published. Written, compiled and edited by practical radio experts of national reputation. Packed with concise, sound information useful to every radio fan—from beginner to veteran hard-boiled owl. Hundreds of illustrations and diagrams to make every point clear. Note this *partial* list of contents:

Different types of receiving and sending hook-ups, electrical terms, condensers, oscillating circuits, coupled circuits, induction coils, antenna systems, electric batteries, generators and motors, protective devices, crystal detectors, arc generators, transmitters, filters, wavemeters, radio experiments, International and Morse codes, commercial receiving sets, tables and data, radio transmitting and broadcasting stations (with call letters), Radio License Regulations, etc.

Send $1 to-day and get this 514-page I. C. S. Radio Handbook before you spend another cent on parts. Money back if not satisfied.

TEAR OUT HERE

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 8251-B, Scranton, Penna.

I enclose One Dollar. Please send me—postpaid—the 514-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

Name.....

Address.....

O'NEIL AUDIPHONE

THE absolutely natural tones of the phonograph now attained in radio reproduction through the O'NEIL AUDIPHONE. Phonograph craftsmen have made a perfect musical instrument and radio acoustic engineers have made it a flawless radio reproducer. Volume without blast. Exterior diaphragm adjustment. The "laminated voice core" makes the AUDIPHONE marvelously versatile.

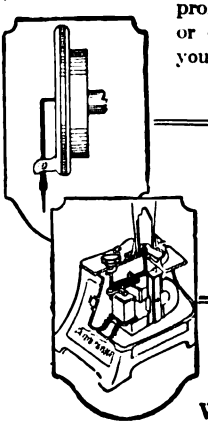
No extra batteries needed. Complete, with connecting cord.

Art Model
Beautiful Antique Bronze Finish
$30

14 Inch Horn
$5 additional

Absolute satisfaction or your money promptly refunded. At your dealers or direct, C. O. D., if you mention your dealer's name.

Write for Literature



Note the similarity of construction between the phonograph reproducer (illustrated in the upper panel) and the reproducer of the O'Neil *AUDIPHONE* (below): both have a mica diaphragm set in a sound-box chamber actuated by an elbow stylus bar.

O'Neil Mfg. Co.

714 Palisade Avenue
West New York, New Jersey

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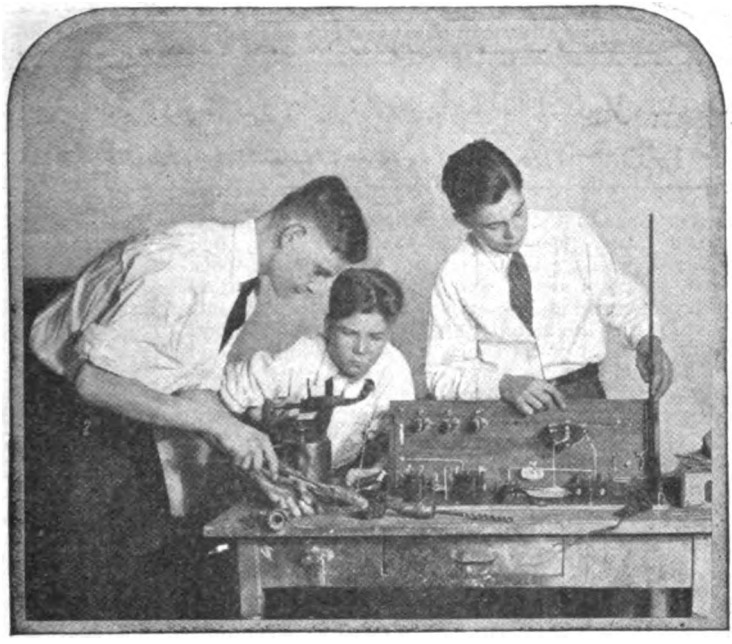

Youth is the creative age in radio

Boys are the builders of radio. In them flames a creative urge that impels them to constant experiment—constant improvement. The fine, high-powered set that satisfies a man is to the boy but the starting point for further testing and searching.

While older men marveled at the first primitive sets, youths still in their teens, like Armstrong, Cockaday, Reinartz and Tuska, were developing the inventions that have made possible such unbelievable advances in this new science. To-day millions of boys, actuated by the same irrepressible urge, are building their own sets, designing new hook-ups, changing, revising, improving. And that's why the bulk of radio sales are made to boys, or to parents buying for boys.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

is the radio guide of 500,000 up-to-the-minute boys, averaging 15½ to 16 years old. Radio takes a big part in its stories. Its articles deal with the latest developments in radio—written by radio authorities. And this great section of boydom naturally turns to its advertising columns for information on all that's newest and best in radio equipment.

Tell these boys about your product. They're the very cream of your market. Win their confidence in your goods, and their preference for them, by advertising in THE AMERICAN BOY.

Copy reaching us by March 15th will appear in May.

THE SPRAGUE PUBLISHING COMPANY
(Member A.B.C.)
548 Lafayette Boulevard **Detroit, Michigan**

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"You can pay more but you can't buy better"

Hook-up any circuit you wish in a few moments—*no drilling or soldering!*

Merely connect the binding posts of R P M *Standardized Units!* Do away with expense, delay and bother of panels, cabinets, drilling and soldering tools. Each R P M Unit is complete in itself—with all wiring concealed and properly insulated to stand exposure. Bakelite mounted—handsome in appearance. Unsurpassed in performance, superior in quality, no body capacity. The finest instruments—yet moderately priced. *Hook-up circuits in every package.*

No. 301 R P M Audio or Radio Frequency Amplifying Unit, completely wired with transformer shielded by moulded bakelite case behind bakelite panel. Without Tube..... $10

RPM

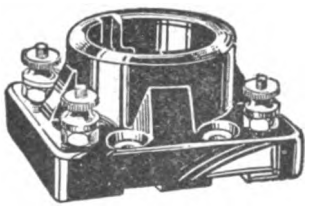
ADD-A-UNIT LINE

Unconditionally Guaranteed

The beginner or the "fan" can easily construct a set of the *finest* instruments—at the cost of a set composed of cheap parts with panel and cabinet—by using R P M *Standardized Units.* There's an R P M Unit for every receiving purpose; mounted and unmounted Variometers, Variocouplers, Variable Condensers, Coupled Circuit Tuners. Also Detector and Amplifying Units. See your dealer.

RADIO PRODUCTS MFG. CO.
667 W. 14th St., Chicago

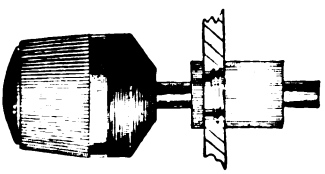
FLERON RADIO SPECIALTIES



The Porcelain Sockets

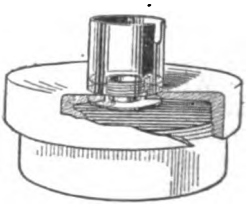
Very carefully made. Brass parts nickeled. Black Glaze. Two sizes. Standard Bulbs and U. V. 199.

Each socket in a carton. **35c.** each.



The Vernier Adjuster

The best adjuster on the market. Spring holds head away from dial when not in use. With slight adjustment spring can be made to hold head against dial if desired. **Patented. 65c.**



The Phono Adapter

Fits through the hole of the receiver cap and then slides on the phonograph tone arm. Fits Victor, Columbia, and others. Works perfectly. Only **35c.** ea.

The Porcelain Insulators

Lowest power losses in the antenna. Dielectric absorption reduced to minimum because of very low phase difference of Fleron Porcelain. Very tough body. Solid Black Glaze. Seven sizes, **20c** to **$1.00.** Each insulator in a separate carton.

The Stand-Off Insulator

Fills the much-needed requirement for a good strong looking and practical stand off insulator. Meets every requirement of the Board of Fire Underwriters. **$1.25** each.

For Sale by all Good Jobbers and Dealers **M. M. FLERON & SON, Inc., 112 No. Broad St., Trenton, N. J.**

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Establishing a New Horizon for Radio!

MU-RAD

RECEIVERS

MA-15

JUST as the telescope widened our vision, so now the new long range receiver, MU-RAD MA-15, has opened up new territories, added to the pleasures of radio. Upon the foundation of MU-RAD sensitivity, easy operation and selectivity, MU-RAD engineers have achieved long range reception with loud speaker volume. Uses only a 2 foot loop aerial. Detector, three stages of radio and two stages of audio frequency amplification.

Guaranteed Reception with a 2 foot Loop Aerial—1000 Miles

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$25 for $10

The New Acoustical Giant

DIRECT FROM FACTORY TO YOU

THE ACOUSTICAL AMPLIFIER
BEL-CANTO
TRADE MARK

NO DEALERS SALESMEN JOBBERS

Their Profit is Your Saving

This is truly a wonderful opportunity to buy this nationally known speaker at a tremendous saving.

Call at the factory, send us your check, money order or pay the postmaster $10.00.

C. O. D. DELIVERED FREE TO YOUR DOOR.

PRICE $10

7 POINTS OF BEL-CANTO SUPERIORITY

1. Our own fiber horn. Crystalline finish.
2. Our own adjustable loud speaking unit, giving a wide range of tone quality and volume without distortion.
3. The base of cast iron, weighing four pounds, eliminating top heaviness.
4. All other metal parts are of heavy cast aluminum, highly polished.
5. Complete instrument stands 24 inches high, 10 inch bell.
6. Guaranteed for one year from date of purchase against mechanical defects of any kind.
7. No auxiliary batteries required. Just plug in on 2nd stage.

GUARANTEE

Money back any time within ten days if dissatisfied. We further guarantee to the publication carrying this advertisement that each and every speaker sold will be exactly as advertised in this issue.

Bel-Canto Mfg. Co.

BENSEL-BONIS CO., Inc., Dept. PR, New York City
General Office and Factory
417-419-421 E. 34th St.
Telephone:
Vanderbilt 8959

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Two **new yearly subscriptions to POPULAR RADIO for only .... $5.**

Rope this Special Offer! You and a friend of yours may each have POPULAR RADIO for a whole year, provided you are both NEW subscribers. Just throw a check for $5 around the double coupon and MAIL IT TODAY.

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Please send POPULAR RADIO for one year to:

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ADDRESS.....
CITY.....STATE.....

And also to this other new subscriber. Here's my cash remittance—(or a check or money order for $5).

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(No extra for Canada. Foreign countries 50 cents extra per subscription.)

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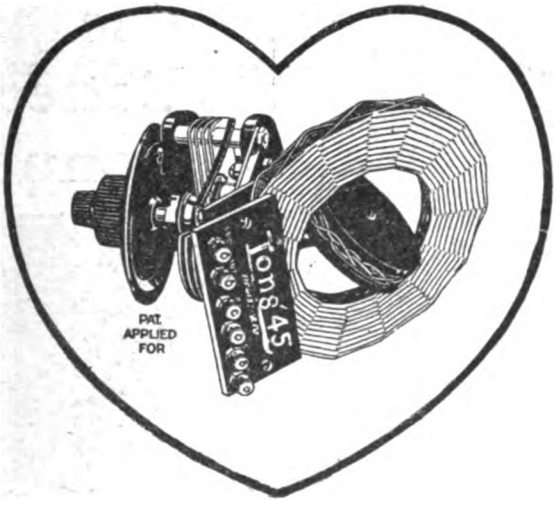

COAST TO COAST

"Long 45"

REGISTERED

is the one tube sensation of the radio world. Letters are pouring in telling of its wonderful effectiveness at little cost. The New York and Chicago newspapers are fully covering the interesting news features regarding the "Long 45" tuner which is the heart of the new Long 45 set. Read what the papers are saying. See it at your dealers. Or write us for particulars.

MARCO MEYER & CO.

1319 MICHIGAN BLVD. CHICAGO, ILL.

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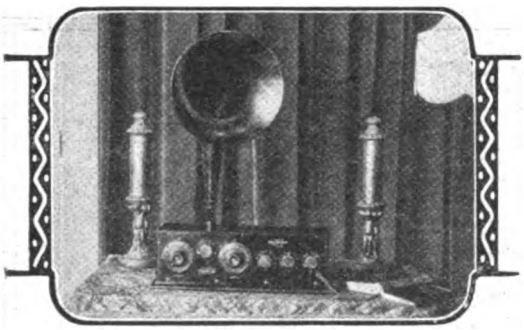


Radiodyne

"The Voice of the Nation"

NO LOOPS - - - NO ANTENNA

The RADIODYNE is ready for operation by simply grounding to a water pipe or radiator, and throwing a few feet of wire on the floor. Uses any standard tubes—dry cell or storage battery. Extremely selective. Simple to operate—***only two controls.***

Stations within a radius of 2,000 miles can be picked up on the loud speaker; any wavelength from 200 to 700 meters. You can select the best programs with the Radiodyne.

PRICE $150.00

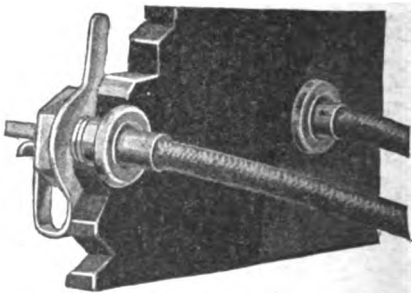
For use in apartments, boats, automobiles, railroad trains, etc., the RADIODYNE is enjoyable where other receiving sets would not be practical.

When interference, strays, static, etc., make other types of reception utterly useless the RADIODYNE picks up broadcast programs clear and distinct.

Write for illustrated folder which describes the RADIODYNE in detail. Every radio fan will be interested in this new type (antennaless) receiving set.

WESTERN COIL & ELECTRICAL CO.
308 5th St. :: Racine, Wisconsin

For Better Connections



Union Radio Tip Jacks

(Patent Pending)

Price 25c a Pair

The greatest little part in all Radio. Just what you need when building sets, or when trying new hook-ups. They replace binding posts and give quick, positive, electrical connections. Heavily nickeled, they add to the attractiveness of your set. Are now adopted by leading set manufacturers because of superior merit over binding posts.

Two sizes for all mountings. STANDARD TYPE A for panels up to ¼" thickness SPECIAL TYPE B for panels, cabinet walls and partitions from $\frac{1}{16}$ to ½" thick. Will firmly grip all wires from No. 11 to No. 24 B & S Gauge. Can easily be reamed to hold antenna wire, loading coil, etc.

Price 25c—in Canada 35c a Pair.

Other Guaranteed Union Radio Parts

TUBE SOCKETS of highly polished moulded condensite. Phosphor bronze contact springs. Reinforced bayonet slot. For all standard tubes. Price 70c.

DIAL ADJUSTERS for minute adjustment of dials, necessary for close tuning. Price 60c.

Retailers—Wholesalers

Write for free samples of our guaranteed reasonably priced Quality Radio Products. Get details of our dealer proposition, also write for your copy of the Union Radio Catalog "A."

UNION-RADIO-CORPORATION
200-MT PLEASANT-AVENUE,-NEWARK-N.J.
NEW-YORK-OFFICE — 116-WEST-32ND-STREET

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The Golden Rule Tube

The Sodion brings a benefit to Radio infinitely bigger and better than any superiority of range, strength or quality of tone.

It opens the way to emancipation from the greatest fault in broadcast reception today—reradiated interference.

Based on an entirely new principle;

Differing materially both in the design and in the arrangement of its elements;

Making an absolutely original use of the peculiar properties of the sodium ion;

The Sodion not only produces stronger signals than any other detector on the market, but it does this without resort to oscillation, regeneration or other expedients.

Just what this means to you—to every other broadcast receiver—and to the art of radio in general, will best be understood when you realize that the whistles, squeals, and howls that interfere so seriously with your reception are due to nothing other than the oscillations in ordinary detectors.

We will send descriptive circular upon request.

Under date of January 21st a Boston user, among other things writes:
"May I add that it is a source of satisfaction for me to know that in operating my Sodion I am in no way interfering with the pleasure of my neighbors."

CONNECTICUT TELEPHONE & ELECTRIC COMPANY
MERIDEN Radio Division CONNECTICUT

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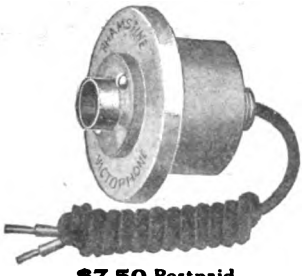
RHAMSTINE* VICTOPHONE



$7.50 Postpaid
Complete with Cord

For All Phonographs and Loud Speaking Horns

In addition to the large diaphragm used in the Victophone, every other detail has been given the closest attention. When incorporated with your phonograph or horn, it will reproduce with the utmost volume and purest tone. No battery required to operate it. Your money back if not satisfied.

It can be furnished to fit all phonographs—the Standard Type fits the Victrola, Columbia, Jewett or Sonora. Specify make of phonograph when ordering. List Price, Standard Type, $7.50.

Order the New Victophone and test it before buying any other loud speaker

RHAMSTINE* VICTOPHONE WITH HORN AND BASE

$12.00 Complete Postpaid

This is a new Rhamstine* Product—combining the popular Victophone with an attractive horn and swivel base. It is a unit which is original in design, neat in appearance, and in connection with the adjustable Victophone, gives remarkable volume.

All parts are nickel plated and polished.

You will be satisfied with a Victophone and Horn. Order yours today.

Manufactured by

J. THOS. RHAMSTINE*

Woodbridge at Beaubien **Detroit, Mich.**

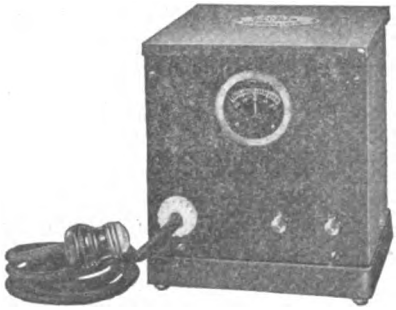
***Maker of Radio and Electrical Products**

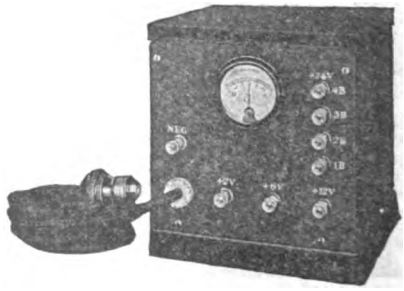
KEEPS THE RADIO SET ALIVE

HANDY CHARGER

A Battery Charger that gives a quick charge economically. No Sticking Contacts. No bulbs nor Liquids. Fully enclosed—beautiful.

SIMPLEX MODEL—For 6 volt Batteries only. The Most Practical, Most Complete Battery Charger, for only **$16.00**





ULTRA MODEL—Charges Them All, Charges 2 volt, 4 volt, 6 volt, 8 volt, 10 volt, 12 volt and 1 to 4 "B" Storage Batteries, with WESTON AMMETER, **$18.00**

INTERSTATE ELECTRIC COMPANY *of St. Louis, Mo.* **4015 Laclede Avenue**

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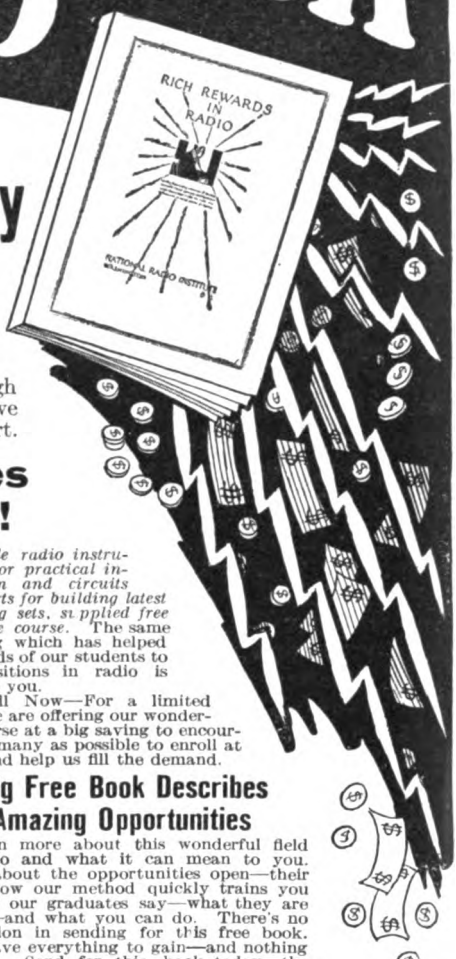
This FREE BOOK on RADIO

Has Shown Thousands How to Make More Money



This wonderful book has opened the eyes of thousands to the amazing Big-Money Opportunities opening right now in Radio. It has shown them how **they** could get their share of the tremendous profits of this newest and fastest growing world industry—**regardless** of what their previous training or experience had been. Hundreds of men today are earning far more than they ever did before—all through having read this Free Book of Radio Opportunities, which we will mail to you without the slightest obligation on your part.

Scores of New Opportunities Waiting for YOU in RADIO!

In the entire history of industry, there probably never has been a business development which can compare with that of Radio! Within a few years it has jumped into the ranks of the world's largest and most profitable fields of endeavor. Broadcasting stations are springing up all over the country. Hundreds of thousands of receiving sets are in operation. Hundreds of ships are installing more and latest equipment. Radio is everywhere being adopted in business. $100,000,000 was spent last year just for receiving sets alone.

This amazing expansion of Radio has opened up hundreds of new positions on land and sea. It has created opportunities never dreamed of in other fields. Big money —fascinating work — advancement—a **real future** in the world's fastest growing industry!

Easy to Learn Radio at Home

If you are ambitious—if you are looking for a field where opportunities are unlimited—get into Radio. Become a Certified Radiotrician—become a highly trained specialist in a new, uncrowded profession.

What Free Book Has Meant to Just a Few of Our Recent Graduates

Triples His Salary As Radio Engineer

Thanks to your course and help it gave me, I have had another boost in pay. This is the third one in less than a year. Today I am getting three times as much as I got before I began your course.
MERLE WETZEL,
Chicago Heights, Ill.

$300 a Month And All Expenses As Salesman

Your course was worth $5000 to me, but I wouldn't take ten times that for the value I've gained from it. I signed up with a company for $300 a month and expenses paid. I owe this to your course. EMMET WELCH,
Peculiar, Mo.

Prepares For All Radio Jobs

It will interest you to know that since completing your course I was 1st operator on Steamship Lake Gilltedge. Last summer I had charge of Broadcasting Station WIAI, and in December connected with the Colin B. Kennedy Radio Corp., as sales correspondent handling all technical inquiries which I enjoy immensely. All due to N.R.I.
WILLIAM WEST,
St. Louis, Mo.

Thousands of Certified Radiotricians are needed to operate broadcasting stations; to design radio sets; to repair and sell radio apparatus; to take charge of radio departments; to operate on board ship or at commercial and government land stations; to go into business for themselves; to fill the hundreds of attractive positions in this wonderful new field.

And now you can easily and quickly qualify in your spare time at home through the help of the National Radio Institute, one of the oldest and largest radio schools in the world. Hundreds of graduates of this school are today profiting by the amazing demand for radio experts. Prominent radio experts **help you in your training.**

Valuable radio instruments for practical instruction and circuits and parts for building latest receiving sets, supplied free with the course. The same training which has helped hundreds of our students to big positions in radio is open to you.

Enroll Now—For a limited time we are offering our wonderful course at a big saving to encourage as many as possible to enroll at once and help us fill the demand.

Big Free Book Describes Amazing Opportunities

Learn more about this wonderful field of radio and what it can mean to you. Read about the opportunities open—their pay—how our method quickly trains you —what our graduates say—what they are doing—and what you can do. There's no obligation in sending for this free book. You have everything to gain—and nothing to lose. Send for this book today—the book that has meant more money to hundreds of our graduates. Mail the coupon NOW. **NATIONAL RADIO INSTITUTE, Dept. 32CF, Washington, D. C.**

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Without obligation, send me your free book "Rich Rewards in Radio," which tells all about the opportunities in Radio, how spare time study at home will qualify me quickly as a Certified Radiotrician so I can get one of these splendid positions and how your free Employment Service helps me to secure a big pay job. Please write plainly.

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NOTE: Radio Firms Secure practical Radio experts among our graduates. Write us today.

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DIAMOND

RADIO PLATE "B BATTERIES"

When you use DIAMOND RADIO PLATE BATTERIES, there's one place less you need to look for trouble. You KNOW they're good for endurance and power beyond other batteries you've had. Don't play tricks with your tubes. Give you more of your money's worth in uninterrupted radio entertainment. Get this better "B" battery NOW. Look for the DIAMOND trade mark.

If your dealer cannot supply you, order direct, C. O. D., naming your dealer

LIST PRICES

No. B-1, 22½ volts, $3.00, 5 binding posts in steps of 1½ volts.
No. B-2, 45 volts, $5.50, 5 positive taps.
No. B-16, 45 volts, $4.50, 5 taps from 16½ to 22½ volts.
No. B-4, 22½ volts, $1.75, for portable sets. 5 taps.
No. 3, Type C, 4½ volts, 70c, 3 taps.

DIAMOND ELECTRIC SPECIALTIES CORP.

102 SO. ORANGE AVE., NEWARK, N. J.

Dealers—Jobbers, Write for Proposition

★"EVERYTONE" *guaranteed* RADIO HEADSET

—two pairs of phones for what you would ordinarily pay for one—and you're not sacrificing quality.

The "Everytone" is an improved type of headset, combining clear reception, comfort and long satisfactory service.

Pacent Universal Plug No. 40

Improved

Connection of cord tips has been simplified—you just insert the tips and clamp the shells together to obtain a sure gripping contact. Polarity is marked on connectors and all metal parts are satin nickel finished. **50c.**

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22 PARK PLACE NEW YORK

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RADIO ESSENTIALS

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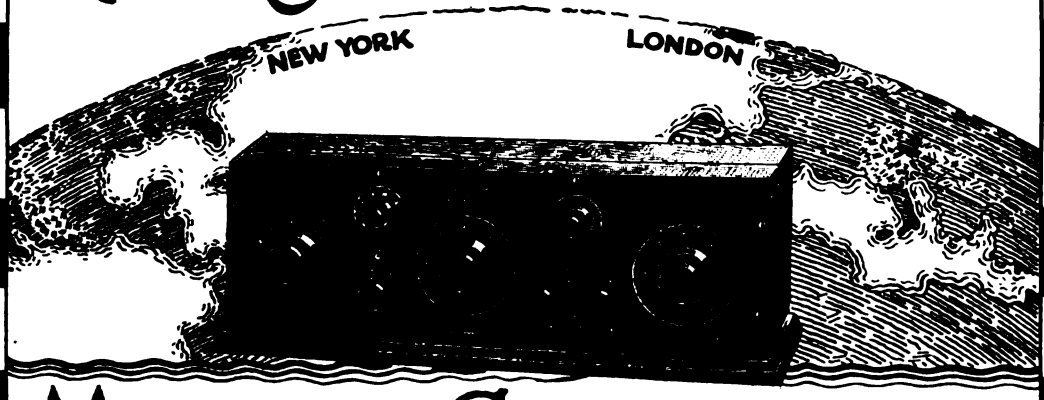
Now Links Two Continents!



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Tuned Radio-Frequency RECEIVER

Satisfies Every Radio Wish

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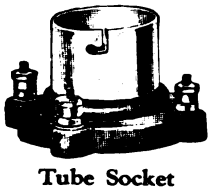
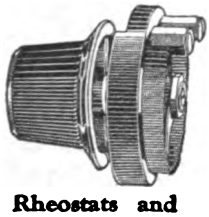


Tube Socket



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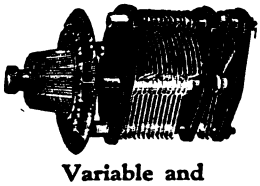

Variable and Vernier Condensers

SURPASSING even the most critical standards of LONG DISTANCE reception, the Melco Inductively-Tuned and Neutralized Receiver leads in trans-oceanic and trans-continental reception. Results are certain whether you are an expert or a novice. The Melco-Supreme adds to its distance supremacy

Extreme Selectivity **Exceptional Clarity**
Simplicity of Operation **Perfect Control**

Each instrument is fully guaranteed

Write for complete descriptive literature

AMSCO PRODUCTS, Inc.

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BROOME & LAFAYETTE STS. NEW YORK CITY

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CICO

Designed by experienced engineers, constructed by skilled workmen, made of the finest materials obtainable, and selling for a popular price, the CICO Bakelite Jack has no equal in the Radio Field today. Bakelite Frame, Phosphor Bronze Springs, and Sterling Silver Contact Points are a few of the many advantages it has over other Jacks. It will give you better results.

Bakelite Jack

A leader for over 2 years. Fits all standard Jacks. Takes all types of tips, forked, straight, and plain wire. No tools of any kind required to hook it up. Loud speaker and headphones or two sets of headphones can be connected simultaneously to the same plug by inserting 2 cord tips instead of one in each terminal. The same efficiency is obtained using one set of phones.

2-Way Plug

Price 60c

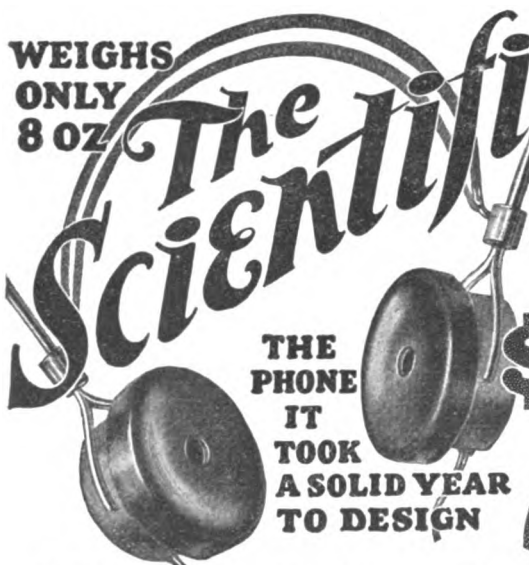
No. 30-Single circuit open $.80
No. 31-Single circuit closed .85
No. 32-Double Circuit ..... .90
No. 33-"A" Battery Switch .90

Consolidated Instrument Co. of America, Inc.
41 East 42nd St., New York

Every CICO PRODUCT is packed in a distinctive GREEN BOX and unqualifiedly guaranteed against all defects.

WEIGHS ONLY 8 OZ

The Scientific



THE PHONE IT TOOK A SOLID YEAR TO DESIGN

A $200,000.00 COMPANY stands squarely back of the guarantee on every *Scientific* headset

SEND NO MONEY!

20,000 TURNS EQUIVALENT TO 3,000 OHMS

$2.95 POST-PAID

Order TODAY by Postcard and Pay Postman on arrival

LOUD SPEAKER UNIT $1.95

We Guarantee The *Scientific* Headset to be the greatest value on the market. Try it for five days. If not satisfactory send it back and your money will be refunded immediately. Circular on request. Dealers wanted.

THE SCIENTIFIC ELECTRIC WORKS

98 Brookline Ave. DEPT. J BOSTON, MASS.

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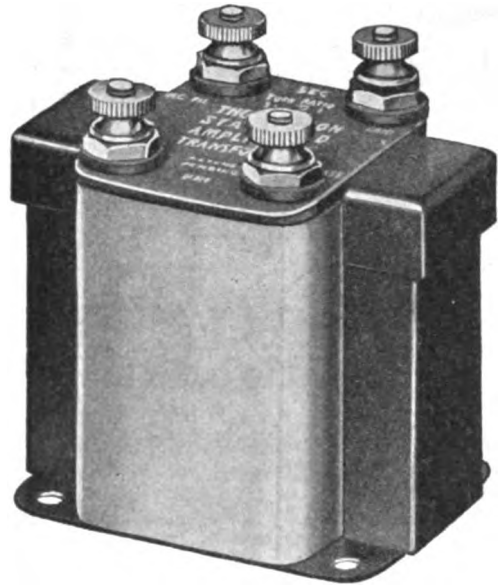
Not claims— just facts!

THORDARSON ELECTRIC MFG. CO.

SUPER TRANSFORMER

AUDIO FREQUENCY

3½ to 1 RATIO	$4.00
6 to 1 "	4.50



Every manufacturer claims that his product is the "best" in the world. But the quality of scientific apparatus is not a matter of claims and opinions, but of facts.

CUTTING & WASHINGTON
KENNEDY
ZENITH

are names that rank supreme in the receiving set world. The superiority of their apparatus does not depend on opinion but is the result of careful construction and scientific selection of parts. All three use the Thordarson Super Audio Frequency Amplifying Transformer, for, after exhaustive tests, it was found to be most in keeping with the high quality of their sets.

AMATEURS
READ THIS

McMillan, preparing for his North Pole expedition, sought the most efficient and durable radio equipment obtainable. His engineers specified Thordarson transmission equipment because Thordarson can be relied on for serviceable distant transmission.

When selecting your apparatus bear in mind the choice of these experts.

THORDARSON
ELECTRIC MFG. CO.

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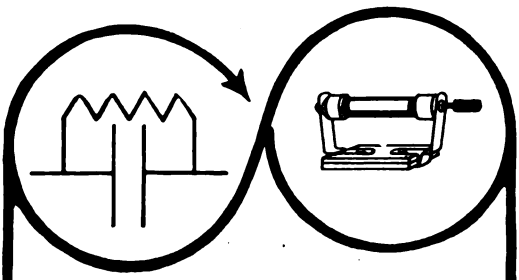


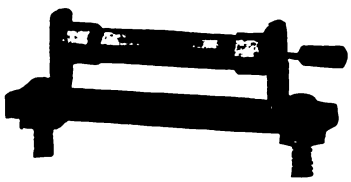
Mr. Cockaday recommends

For Volume Control of the improved

4-Circuit Tuner

DURHAM Variables

High Resistance ask for Durham No. 101 0.1 to 5 megs.



Complete with base $1.05
Use also for Grid Leak

DURHAM Variables have a reputation built on their close control of the grid circuit. One-finger plunger adjustment is accurate and reliable.

No. 101—0.1 to 5 megohms
No. 201A—2 to 10 "
Price, 75c each

Fit standard grid condenser bases—or Durham base, 30c extra.

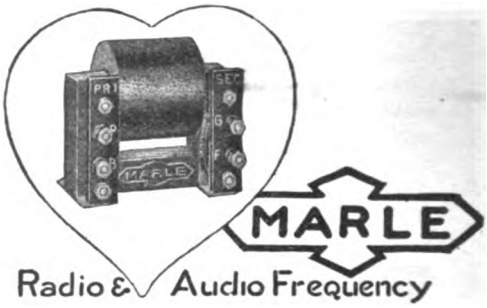
Sent postpaid on receipt of price—if your dealer is not stocked

Free folder "C" gives more details. Get yours from dealer or write

Satisfaction Guaranteed

DURHAM & CO., *Inc.*
1936 Market St., Philadelphia

Dealers: Recommended by experts Durhams move lively



MARLE

Radio & Audio Frequency

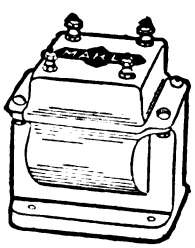
TRANSFORMERS

"The Heart of a Good Receiver"

PERFECT AMPLIFICATION is the boon you secure when you buy a MARLE TRANSFORMER. Radio impulses are magnified to the uttermost limit without a sign of distortion. True over the widest range of frequencies. Special folders, showing the hookups for standard circuits, sent upon request.

Write for hookups and Illustrated Folder TODAY!

Your Dealer sells Marle Transformers or write to us for the names of the nearest Marle Dealers.

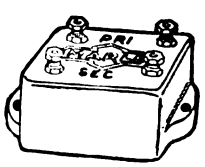


MARLE Engineering Company

Orange New Jersey

Audio F

Ratio of 3¾ to 1



Radio F

Types R1 and R2

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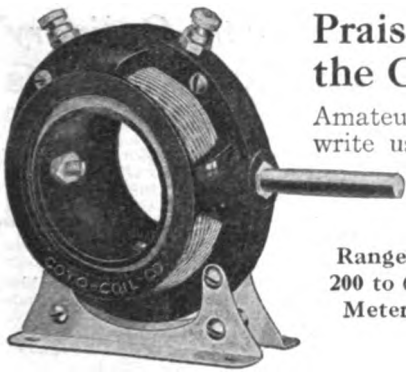
Coto
"Built First to Last"

Follow the Lead of Experts for Assured Results in Radio

You do not find the experienced radio experimenter taking chances with nondescript parts. He has long since learned the lesson of time and temper wasted. He knows the A. B. C. of radio—"Always Buy Coto"—and he will tell you it is a mighty good rule.



Range is 200 to 600 Meters

Praises from all Quarters Greet the Coto Compact Variometer

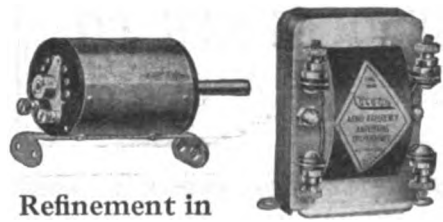
Amateurs, Experimenters and Beginners all write us their stories of success with this remarkable new Variometer. Stator coils are honeycomb wound. Rotor is connected with pigtails to avoid "clicky" contacts. Tuning is even over all broadcasting wave lengths. Quality second to none at a popular price. $5.

Write for Folders

Write us for folder describing all Coto Radio apparatus. Enclose name and address of your dealer and list of parts you need. We will see that he supplies you without delay.

Read Carefully Our GUARANTEE

Coto Apparatus is designed and made to give the best possible results in standard radio circuits.
Its national reputation for excellence is based on good honest performance under all conditions.
So we guarantee each Coto Radio Part to the limit, authorizing all dealers to replace without question for any defect. .



Refinement in
Radio and Audio Amplification
is assured by use of Coto Tapped Radio Frequency Amplifying Transformers (Type 5000A) at $7.50 and Coto Compact Audio Frequency Amplifying Transformers (Type 4000) at $5. The former covers the entire broadcasting range. Just turn the switch. The latter is 5 to 1 ratio of best shell type, remarkably efficient and true in tone.

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87 Willard Ave., Providence, R. I.

Los Angeles, 329 Union League Bldg.
Minneapolis, Geo. F. Darling, 705 Plymouth Bldg.
Atlanta, C. P. Atkinson, Atlanta Trust Co. Bldg.
Canada, Perkins Electric Co., Ltd., Montreal Toronto Winnipeg

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RESISTRON The Perfect GRID RESISTANCE!

Its the MERCURY that does the TRICK

RADIO FANS everywhere are astonished and delighted with the new vim and vigor RESISTRON adds to their sets. Increased distance, reduced distortion, greater amplification are all to be secured with this perfect grid control! You don't know the capabilities of your set until after you've attached "RESISTRON!"

$3. West of the Mississippi

TEMPLE INSTRUMENT CO. Camden, N. J.

Put on RESISTRON *- and go to the* COAST

RIGGS RECTIFIER

TYPE B-3

ONLY

$12.50

Small, compact, efficient.

Operates on 110 volts A. C. 60 cycle.

Charges 6 volts 6 amperes.

In Universal use.
Charges at minimum cost.
No bulbs to break.
Special contact points.
Simple to operate.
Shipping weight 9½ lbs.
Delivered in U. S.

FULLY GUARANTEED

THE RIGGS MFG. CO.

Box 304 Everett, Wash.

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The Saturn

"Above the Ordinary" Radio Products

Automatic Plug

Nothing to take apart. Cord terminals inserted, instantly gripped; a touch on the lever, instantly released. Each Saturn Plug sealed to protect you. Guaranteed.

List Price $1

Perfect Jack

Crowfoot offset and solder and flux on blades all ready for soldering. Best materials—Spring German silver blades, rounded corner brackets of nickel-plated brass, and sterling silver contact points. Quality throughout.

List Prices

No. 1	Single Circuit, Open	50c
No. 2	" " closed	55c
No. 3	Double " "	70c
No. 4	Single Filament control	75c
No. 5	Double " "	80c

Write for Folder

The SATURN Mfg. & Sales Co.
48 Beekman St.
New York, N. Y.

SUPER-HETERODYNE

"The Rolls-Royce of Reception"

TYPE "S R" Radio Frequency TRANSFORMERS

An instrument especially designed to amplify at a sharp peak of 10,000 meters, and perfected to function at maximum efficiency in the best designed receiving apparatus in the world.

THE RIEGER-BAILEY CO. OF AMERICA

Price $7.00
at best radio dealers or direct from the manufacturer. Give dealer's name if ordered direct.

539 Real Estate Trust Bldg.
Philadelphia, Penna.
Bell Telephone Walnut 7475

DEALERS and JOBBERS
will find this a particularly active and attractive line. Write for details.

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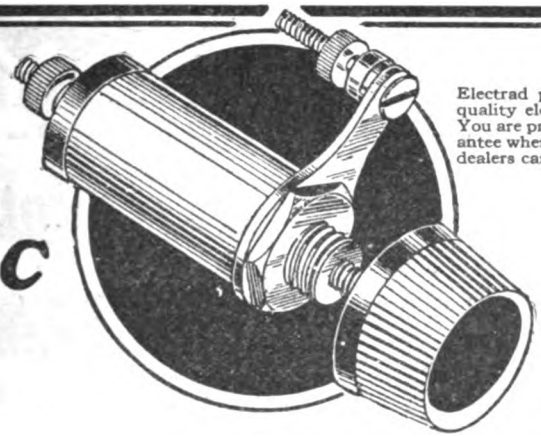


75c

Electrad products are of the highest quality electrically and mechanically. You are protected by an absolute guarantee when you buy them. Most good dealers carry them.

Double your distance with this Variohm

THE latest invention in grid leaks enables you to get exactly the correct resistance for your individual set as it receives in your home. With the Variohm you can secure and maintain any resistance from ½ to 30 megohms. Once adjusted to your individual set, the setting is permanent.

With it you get maximum distance and sensitivity. Without it your set is working at a disadvantage. It eliminates circuit noises, is moisture-proof and non-microphonic. Suitable for panel or base-mounting. Unmounted 75c, mounted $1.00. Equipped for use with standard fixed condensers.

Displayed, sold and recommended by most good dealers. If your dealer cannot supply you, send us his name and purchase price and we will send it to you post-paid. Satisfaction guaranteed or money back.

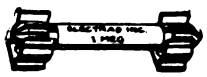
Dealers Electrad Radio Products of guaranteed superior quality offer you wonderful opportunities for quick turnover and good profits. Write for details on our greatly increased advertising campaign, dealer helps and package of fast moving items.

Electrad, Inc., Dept. C, 428 Broadway, New York, N. Y.

ELECTRAD

a name stamped only on Superior Radio Products

Other Electrad Products of Superior Quality & Dependability

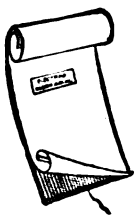


FIXED GRID LEAKS

Absolutely uniform, unvarying fixed resistance. A superior product of dependability in all resistances from ¼ to 10 megohms. Price 30c.

LEAD-INS

No longer do you need to ruin your window frames. Electrad Lead-Ins fit under closed windows, can be bent to any shape. Covered with fireproof insulation of 1000 volts resistance which prevents grounding on wet sills. Fitted with Fahnestock Clips 40c.



INDORARIALS

Ideal for sharp tuning. Wonderful directional effects. Reduces static. Can be used anywhere. Hang on door or wall behind draperies or laid under rug. Can also be used as ground. Price $1.50.

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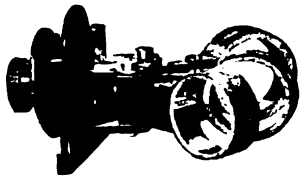
BRANSTON RADIO

BRANSTON UNIVERNIER THREE-COIL BACK-OF-PANEL GEARED MOUNTING



This is the latest Branston Honeycomb Coil Mounting (R-63). A complete unit. Mounts rigidly on back of panel. Nothing on front of panel but two large closely-graduated dials. Unit has its own terminal block. Spur and bevel gears move coils accurately and give remarkable selectivity. With dial graduations you can "log" stations with precision. Made of genuine Bakelite throughout. Strong and substantial. If your dealer has not yet secured his supply, send check or money order for as many as you need, at $8.50 each, or order parcel post C.O.D. Mention your dealer's name, please.

Branston Honeycomb Coil Mountings are made in two and three coil types, both for front and back panel mounting, geared and plain. There is one to meet every requirement. Branston Honeycomb Coils are made in sixteen sizes. —Use the two or three coil combinations that give you the wave lengths you desire.

SUPER HETERODYNE

Special Announcement

Write for complete information and prices on the following apparatus, which we have specially designed for Super-Heterodyne circuits.

No. R-90 Oscillator Coupler. Complete with mounting brackets, bank wound inductances and adjustable coupling coil with locking device.

No. R-91 Intermediate Radio Frequency Transformer. Very sharply tuned and shielded.

No R-92 Special Transfer Coupler for last Stage of Intermediate Frequency. Very sharply tuned and shielded.

No. R-93 Specially Designed Coupler. For using antenna.

Send 2c Stamp for New Honeycomb Coil Hookups.

Look for this trade-mark card in your dealer's window or salesroom

Compiled by experts and includes five good Honeycomb Coil "Hook-ups" and complete catalog of famous Branston Radio Apparatus. Write today. Give us name of your radio dealer. If he cannot supply you, write

Chas. A. Branston, Inc.

811 Main St.
BUFFALO, N. Y.

Manufacturers of Branston Violet Ray High Frequency Generators

In Canada
Chas. A. Branston, Ltd.
Toronto, Ont.

Genuine-
E. J. Flewelling
PARTS

A socket in which **the good** points are **obvious upon** inspection. **Ideal** for Radio **Frequency**—excellent **for all other** circuits. **Price $1.00.**

A tuner of maximum **efficiency** owing to the **elimination** of **unnecessary** dielectrics **and taps.** Has fine **tuning control** and in **conjunction** with a **good condenser**, covers a **broad** wave band **without** coil change. **Adaptable** to all circuits. **Dial** included. **Price $8.00.**

The condenser that won **such wide** praise at the **Chicago** Radio Show. **Extra heavy** plates and **rugged construction.** **Will last** a lifetime. Electrical **efficiency** equal to **any. Available** in .005 **mfd. capacity**—23 plate. **Price $7.00.**

At Your Dealers or Direct

Genuine Flewelling Parts are **manufactured** exclusively by ***Buell Manufacturing Company***, **under** the personal **supervision** of Mr. E. T. Flewelling.

BUELL MANUFACTURING COMPANY
2979 Cottage Grove Avenue, CHICAGO

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How turning this knob gets more stations

RADIO FREQUENCY AMPLIFICATION with the BALLANTINE VARIOTRANSFORMER
Signal Strength
BALLANTINE VARIOTRANSFORMER
Fixed Transformers of good makes
Wave length-Meters
Tests made by the Radio Frequency Laboratories Inc.

BALLANTINE VARIOTRANSFORMER

HERE'S evidence that the tuning dial of a Ballantine Variable R. F. Transformer gives superior results. The light line curves (plotted from careful experiment) show you that fixed transformers do not give satisfactory amplification for many of the important stations. Why? Because the *fixed* windings are out of tune.

With Ballantine instruments you can accurately tune everything from 200 to 600 meters—by merely turning the knob. This adjusts the windings to the wave length of the station wanted.

Get Stations You've Never Had

Perfect shielding and pig-tail connections assure clear tones. Then, by keeping amplification uniformly high throughout the broadcast range, you get all there is within reach of your set.

Here's an assembly ready to hook into your present set — *tube or crystal.*

Complete radio frequency amplifier unit with socket and rheostat $15.00

Transformer only for panel or base $9.60

At dealers or postpaid

Send for This Booklet

"Radio Frequency Amplification with the Ballantine Variotransformer," 25 pages of practical interest. Mailed to Radio experimenters upon request.

BOONTON RUBBER MFG. CO.
Pioneers in Bakelite Moulding

224 Fanny Road, Boonton, N. J.

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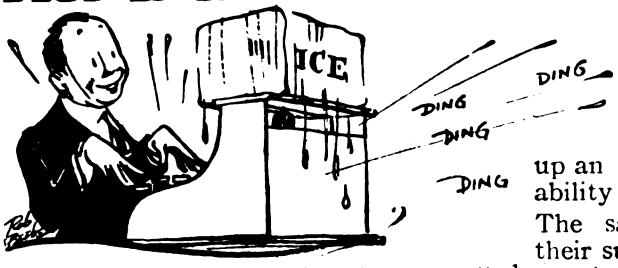
HOMMEL SERVICE MAKES MORE PROFITS



THIS company has been wholesale distributors of high grade electrical equipment for over 16 years and have built up an enviable reputation for dependability and service.

The same principles responsible for their success in the electrical field have been applied to their activities in the radio field. They wholesale exclusively,—they never compete with their dealers by retailing;—their discounts are fair and liberal;—they represent only the leading manufacturers of radio equipment;—they carry complete stocks of radio supplies insuring prompt deliveries and a dependable source of supply for the dealers.

Dealers who align themselves with HOMMEL service enjoy a steady repeat business, with satisfied customers, and that means more and better profits.

DISTRIBUTORS FOR
Radio Corporation of America
RCA
Westinghouse General Electric
Acme Atwater-Kent
Baldwin Brandes Burgess
Chelsea Cunningham
Cutler-Hammer
Dubilier Fada Frost
Freshman General Radio
Grebe Homecharger
Murdock
Remler Rhamstine
U.S. Tool Western Electric
And other
leading manufacturers

Let us send you complete facts—
Encyclopedia No. 246-P sent on request

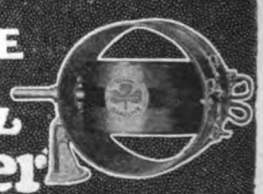
LUDWIG HOMMEL & CO

530-534 FERNANDO ST. — PITTSBURGH, PENNA

An Absolute Guarantee
with every instrument
made them famous!

SHAMROCK
FOR SELECTIVE TUNING
180°
Vario-Coupler
list price,
$3.50 *each*

DOUBLE
DUTY
PIG-TAIL
Variometer



SHAMROCK MFG. CO.
314 E. Market St. — Newark N.J.

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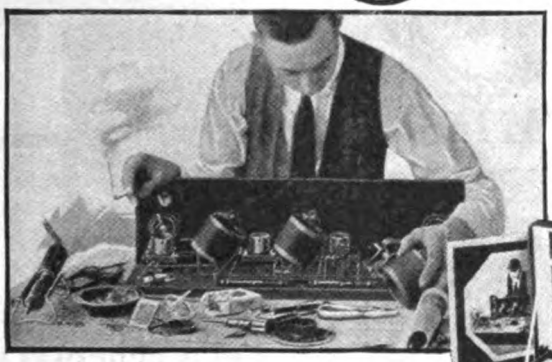

The Neutrodyne parts illustrated below sell at $25. The complete parts for a 4-tube set, everything included down to the last screw, sells at $64. For those who wish to build a 5-tube Neutrodyne receiver the complete knockdown parts are sold at $65.60.

FADA parts for NEUTRODYNE Radio Receivers

The Neutrodyne receiver has proved to be the most efficient yet devised for broadcast reception. In selectivity, distance getting, volume and clarity it has no equal.

To make a Neutrodyne receiver requires care in construction and the use of parts that are mechanically and electrically perfect. The electrical characteristics of the Neutroformers and Neutrodons are so exact in their requirements that their manufacture requires radio engineering knowledge and skill of the highest order.

FADA parts for Neutrodyne receivers are made under the direction of experienced and expert radio engineers. Every part is mechanically and electrically perfect. Those who have used them testify to the wonderful results produced by sets made with FADA parts and following FADA instructions. Your dealer can furnish FADA parts for four and five tube Neutrodyne sets.

Our booklet, *"How to Build Neutrodyne Receivers"*
is included with each combination of FADA parts, or may be had direct or from dealers at 50 cents per copy.

F. A. D. ANDREA, INC., 1581 Jerome Avenue, New York City

FADA Radio

F. A. D. ANDREA, INC., 1581 Jerome Avenue, New York City

Gentlemen:

Enclosed find fifty cents { ☐ Stamps / ☐ P. O. Order } for which send me your book on "How to Build Neutrodyne Receivers."

Name.....

Street Address or R. F. D......

City or Town.....**State**.....

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RADIO
BIG MONEY IN A FASCINATING INDUSTRY

FREE With Our Home Study Course

Right at home you can speedily qualify yourself to accept big paying positions in the great field of Radio. Never before such sensational opportunity. Get in on the ground floor. We start your training by giving you this wonderful tube receiving set. Range up to 1000 miles. ABSOLUTELY FREE. Our practical instruction method guarantees your success—you learn by actual work on the set.

ENORMOUS DEMAND FOR EXPERTS

From everywhere comes the call for Radio Experts. Big salaries are waiting for trained men who can construct, install, operate, repair and sell radio equipment. Tremendous profits can be made in your own neighborhood taking orders for sets. Thousands are winning success in this fastest growing industry—you can too.

Turn Spare Time Into Cash

Just a few hours each week of pleasant home study trains you in amazingly short time. Make your spare time earn you cash. We show you how. Many are earning from $3,000 to $10,000 a year.

A. G. MOHAUPT, Radio Engineer,
American Radio Ass'n
4513 Ravenswood Ave., Dept. 53 Chicago

Mail Coupon

A. G. MOHAUPT, Radio Engr.
American Radio Ass'n,
4513 Ravenswood Ave., Dept. 53, Chicago, Ill.

Please send me details of your Home Study Course—also your Free "Radio Facts" and information on how I can get a FREE 1000 mile Radio Set.

NAME.....

ADDRESS.....

CITY..... STATE.....

DESIGNED ESPECIALLY FOR RADIO RECEIVING

We are Manufacturers of Fine Furniture and we sell direct to you with only a small factory profit.

A handsome hardwood hand-rubbed mahogany or golden oak finished Radio Table. Size of top 20 x 34 inches x 31 inches high.

Conceals A & B batteries. Small drawer holds Tools and accessories.

PRICE, FREIGHT PAID, East of Mississippi River.....**$18.00**
FREIGHT PAID to Rocky Mt. States...**20.00**
FREIGHT PAID to Pacific States.....**22.50**

Cash with order. Prompt shipment.

CABINET PRICES REDUCED!

Hardwood, hand-rubbed mahogany finish. Hinged top.

Panel Size	Depth	Price
6 x 7 in.	7 in.	**$2.25**
6 x 10½ in.	7 in.	**2.50**
6 x 14 in.	7 in.	**3.00**
6 x 21 in.	10 in.	**3.75**
7 x 18 in.	10 in.	**3.50**
9 x 14 in.	10 in.	**3.50**
12 x 14 in.	10 in.	**4.00**

POSTPAID, East of Mississippi River.

POSTPAID to Rocky Mts. states, add 25 cents.

POSTPAID to Pacific states, add 50 cents.

Cash with order. Prompt shipment.

Send for free catalogue of Radio Furniture.

THE SOUTHERN TOY CO.
HICKORY, NORTH CAROLINA

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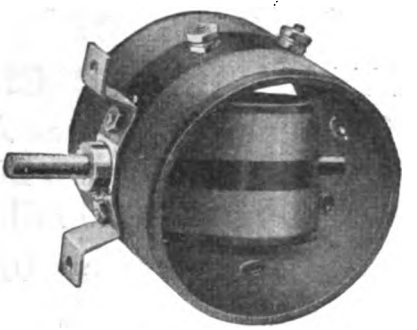
A NEW PRODUCT

The compact, panel mounted set is the established practice of today. It is no longer considered good design to construct a set that will operate over the entire commercial radio wave length range. The popular set is one designed particularly for broadcast reception. There are many circuits that may be used and the enthusiastic radio man usually desires to try several at least.

Standard, guaranteed parts designed particularly for the broadcasting band of wave lengths enable the experimenter to get the maximum results when new circuits are tried. The General Radio Company products, with a decade of proven quality, insure the results you desire.



TYPE 268

VARIO COUPLER

In order that General Radio products may be used throughout on your set a new vario coupler has been designed. This instrument is compact, rugged, has low losses, and a wide wave length range. The forms are of bakelite, not a substitute compound, the bearings are tight and very smooth running. The stator is provided with a center tap. Like every other General Radio product it is fully guaranteed.

PRICE $3.50

Send for Bulletin 917-U

GENERAL RADIO COMPANY

Massachusetts Avenue and Windsor Street

CAMBRIDGE 39 MASSACHUSETTS

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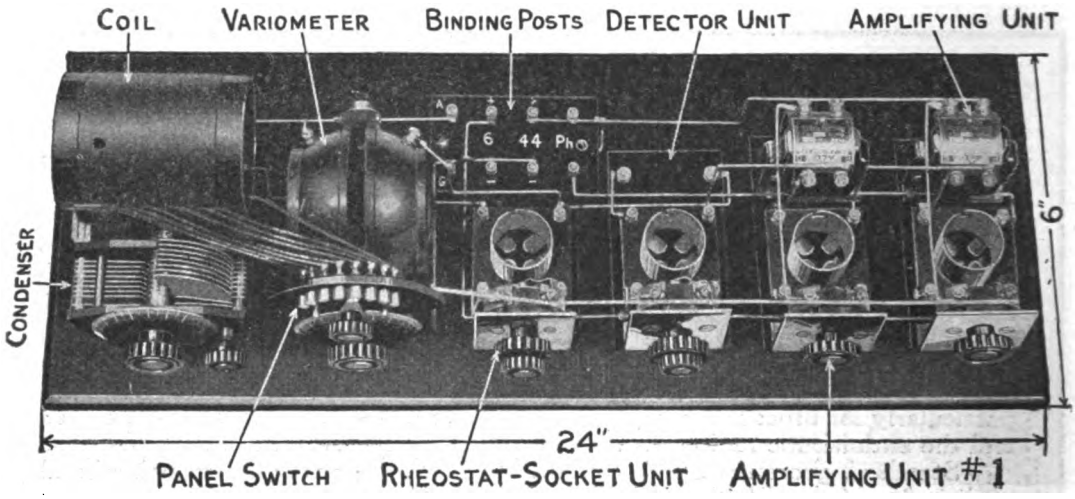

Tuned Wave Trap Radio Frequency Receiver

BUILT ON FAMOUS COPP CIRCUIT No. 4

1 Stage Radio-frequency—2 Stages Audio-frequency
Efficient for all wave-lengths from 200 to 700 meters
Range up to 2000 miles

Any person can build the above set with A-C DAYTON Complete Units

$43.35

Units packed complete in one carton with wiring diagrams, photographs, instructions, etc., for complete installation.

SEE YOUR DEALER OR WRITE US DIRECT

We manufacture a complete line of Radio Parts and Units—Catalog on request

THE A-C ELECTRICAL MFG. CO., Dayton, Ohio

Makers of Electrical Devices for over 20 Years.

We Offer Cash for Your Spare Time

MAIL the little coupon today. It will mean money to you.

For every subscription to POPULAR RADIO that you send us, we will reward you liberally in cash commissions.

Many of your friends and acquaintances will be glad to subscribe to POPULAR RADIO when they see what a helpful and interesting magazine it is. You can do your friends a good turn and at the same time make money for yourself by taking their subscriptions for POPULAR RADIO.

Mail the coupon today for full particulars and a free sample copy

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Please tell me how I can make money in my spare time taking subscriptions to POPULAR RADIO. Send along a sample copy for me to work with; also other necessary supplies.

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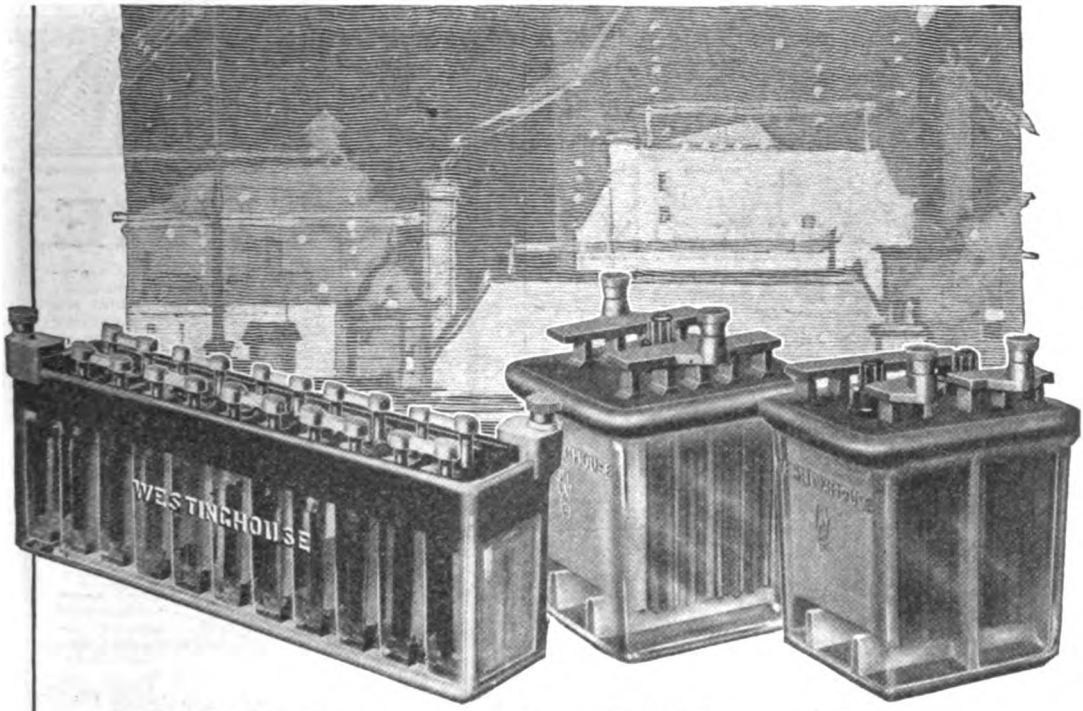

NOTHING about a radio set is so absolutely essential to satisfactory receiving as *good batteries*. Sustained voltage, slow, even discharge, ample capacity, utmost quiet, long life—these are important. Don't be satisfied with anything less than Westinghouse Radio Storage Batteries. They are built to meet the most exacting requirements of radio broadcast transmission and reception. And they last! Thoroughly insulated against current leakage. Easily recharged. A size and type for every radio need.

MAIL COUPON for interesting facts about batteries.

Westinghouse CRYSTAL CASE Radio Batteries have one-piece clear glass cases, with glass cell partitions and high glass plate rests (deep sediment spaces). **"A" Batteries** in 2, 4 and 6 volt sizes. 6-volt size made in rubber-case types too. **"B" Batteries** in 22-volt units—regular and quadruple capacities. **"C" Batteries** in 6-volt units.

WESTINGHOUSE UNION BATTERY COMPANY, Swissvale, Pa.

WESTINGHOUSE

RADIO

"A," "B" and "C"

BATTERIES

Westinghouse Union Battery Co.
Swissvale, Pa.

Send me Westinghouse Radio Battery Folder A-3-B.

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For All Batteries

Longer distance and clear signals are the pleasing results which you can be sure of when both the A and B batteries of your radio set are storage batteries. No other source of power for radio equals the storage battery.

The Valley ABC Battery Charger is so simple and so easily operated that it makes storage batteries the most convenient and inexpensive source of power for radio. Enjoy radio at its best. Use storage batteries and charge them with The Valley ABC Battery Charger.

Charges 2-volt peanut tube batteries, 6-volt A Batteries, 6 and 12-volt automobile batteries, and 1 to 4 B batteries. Bakelite panel, glass sop. Harmonizes with any receiving set. At good radio shops.

VALLEY ELECTRIC CO.
3157 S. Kingshighway · St. Louis, Mo.

Valley Battery Charger

1500 MILE RANGE

VACUUM TUBE RADIO SET READY BUILT

$19.95 REG. VALUE $57.50

1,500-mile range attained in favorable weather with **Atlas Wizard** Single Tube Radio Set. Wonderful selectivity—clear tone reproduction—brings you melodies, music and market reports. Dials log with accuracy of a Neutrodyne.

One ATLAS WIZARD Radio Set completely built, to one person in each community, only **$19.95.** Don't fail to take advantage of this amazing offer. Name and address brings set complete by express C. O. D. You take no risk so order this Radio wonder today.

WHAT YOU GET
Atlas Wizard Receiver, mahogany finish; Head Phones; Vacuum Tube; A & B Batteries; Aerial; Ground Wire; Instructions.
READY BUILT

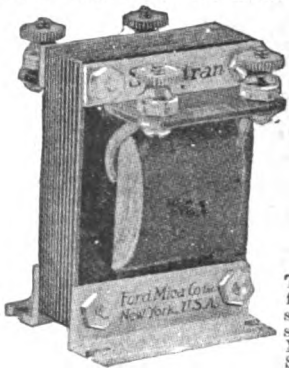
ATLAS CUT RATE RADIO STORES
Div. 21, 345 S. Clark St., Chicago
Send 35c in stamps for Atlas Wizard Blueprint. Big Radio Catalog FREE.

SUPERTRAN

Registered U. S. Patent Office

VOLUME

The Supertran TALKS while other transformers whisper! The reason for its enormous sound amplification lies in the skillful engineering design,—the result of years of intensive research and study.



***Price* $6.00**

These transformers are specially designed for the Neutrodyne Set.

Can be used with any amplifying tube on the market with excellent results

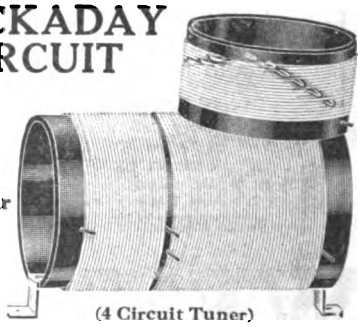
At your dealer—or direct by mail on receipt of purchase price

FORD MICA CO., Inc.
33 East 8th St. New York

EASTERN COIL SETS

for the **COCKADAY CIRCUIT**

are the Standard, and in Universal Use due to their Proved Efficiency in this wonder circuit



(4 Circuit Tuner)

Made as per specifications of Mr. Cockaday, "D" Coil bank-wound.

Complete assembled Set of B, C and D Coils on GENUINE BAKELITE TUBING, wound with #18 double silk covered wire **$4.25**

Original and new improved hook-ups with material lists FREE with each set of coils.

Genuine Lavite Resistances, 48000 ohm, each **$1.50**
These resistances *control* the *tone* of the Cockaday Circuit and eliminate all transformer distortion; modulating the tone after the fashion of the best of phonographs.

Mail Orders Filled. Dealers Communicate.

EASTERN RADIO MFG. CO.
22 Warren Street, Dept. P. R. NEW YORK, N.Y.

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Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

A. J. HAYNES
Assoc. Institute of Radio Engineers

NEW AND IMPROVED RADIO APPARATUS

Designed by A. J. Haynes

Mr. Haynes has made many valuable contributions to Radio. Featured in this advertisement are four pieces of apparatus designed and perfected by Mr. Haynes after extended research. Each of these items represents an invaluable contribution to the art of Radio.

The Haynes Condenser

$3.50

Meets every requirement — extreme low minimum capacity and maximum capacity of exactly .00023 mfds. No other condenser is exactly like it—no other achieves exactly the right balance between perfect selectivity and over-critical adjustment.

The Haynes Bank Wound Vario-Coupler

$4.35

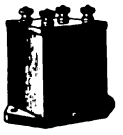
Furnished with only the taps you actually use and just the right number of turns on the secondary. Bank winding provides 100% efficiency on higher broadcasting wave lengths.

FOR RADIO EXPERIMENTERS

F. and K. .0005 Microtune Vernier Condenser	$5.80
¼ meg grid leak	.50
.005 fixed condenser with transformer mounting	.60
Fada Socket (Standard)	1.00

Haynes-Griffin Transformer

$4.25



An efficient intermediate wave radio frequency transformer giving a minimum of audio frequency amplification. Uniformly tuned to a limited wavelength range, and providing a degree of quietness and stability heretofore unknown in transformers of this type. Haynes-Griffin Input Transformer also, $4.25.

Special Oscillator Coupler

$3.50

An indispensable adjunct for those who want the best results from the most advanced circuits.

Supplied with necessary leads already attached.

OTHER NEW APPARATUS

.5 Mfd. By-pass Condenser	$ .90
Haynes-Griffin Precision Grid Leak (Every one tested for exact resistance)	.60
Como Push-Pull Transformers (pair)	12.50
Bradley leak ⅛ to 10 meg	1.85
Amplex grid-densers	1.25
Haynes-Griffin Head Phones—2400 Ohms	4.75

SEND FOR COMPLETE PRICE LIST

Located in New York City, the headquarters of the radio industry, Haynes-Griffin is always first in marketing new and improved apparatus.

Our new price list—just off the press—brings you up-to-date in radio. Everything that's new in radio included. Mailed anywhere upon receipt of 4c in stamps. Use the handy coupon.

Parcel Post Prepaid in U. S. anywhere east of the Mississippi River.

New York's Largest Radio Store

Haynes-Griffin
145 W. 45th St.,
New York City

Send me at once complete price list of new and improved radio apparatus. I enclose 4c in stamps for same.

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HAYNES-GRIFFIN RADIO SERVICE, Inc.
Mail Order Dept.—145 W. 45th ST., N. Y. City
Retail Store—41 W. 43rd ST., N. Y. City

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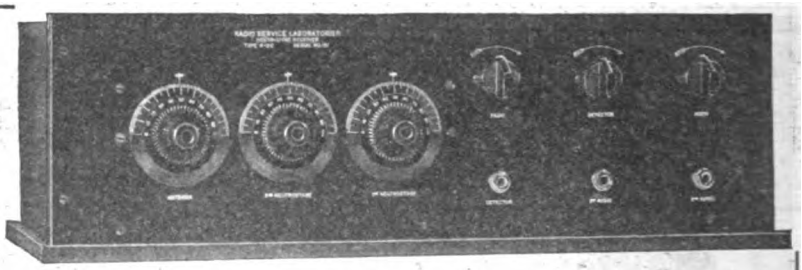
"The Best Built Set in America" R-212



RADIO SERVICE LABORATORIES

Embodying the Hazeltine Neutrodyne circuit in an improved form as to neutralization, workmanship, quality, appearance and efficiency of operation.

Licensed by I. R. M., Inc., under Hazeltine Patents

Radio Service Laboratories, 1000 11th Ave. Asbury Park, N. J.

Five-Tube FADA Parts!

HAVEN'T you often wanted a REAL Neutrodyne? Everyone is using this King of Circuits to enjoy trans-continental and trans-oceanic programs!

Having specialized in the Neutrodyne since its inception, we unqualifiedly guarantee astounding results using the ORIGINAL FADA Neutroformer parts. 2,000 miles on a loud speaker! 500 mile stations only "locals"!

Hundreds of our clients praise the PERFECTION-FADA receiving outfit. All the parts are yours at $79.50—in addition we give you a beautiful mahogany cabinet—FREE!

Don't hesitate! Own a Neutrodyne now! If you are afraid of tackling the job—we will build it for you and without charge of any kind, at the same price, $79.50! Everything guaranteed! Accessories not included.

Mahogany Cabinet Free!

$79.50

Built for You FREE!

Our Six-Store Organization Guarantees You Satisfaction

PERFECTION RADIO CORPORATION
119 W. 23rd St. New York City

Radio Veterans Demand

"Dependable"

TRIMM HEADSETS

"Professional" $7.65 **"Dependable" $5.00**

Positively the only headset on the market sold with a lifetime guarantee that covers every detail of materials and workmanship, excepting only cords and shells which cannot be guaranteed against breakage if dropped. Absolutely no charge AT ANY TIME for repairs, replacements or re-magnetizing. The headsets to buy and to sell.

See! Hear! These

TRIMM LOUD TALKERS

All fitted with Special TRIMM jumbo size loud talker unit

ACOUSTICOLA	Phonograph Attachment	$10.00
ACOUSTICOLA	with composition horn	22.50
ACOUSTICOLA GRAND	with cast aluminum horn	35.00

Write for folder. Or order samples with privilege of return after 5 days examination and test

TRIMM RADIO MFG. CO.

Dept. 59, 24 S. Canal St., Chicago

LOOK FOR THIS SIGN

Wherever it is displayed you will find an active dealer selling our quiet, non-carbon, 100% efficient grid leak. 75c, from dealer or manufacturer.

CHAS. E. BONINE

TURN-IT ADJUSTABLE GRID LEAK

PERFECT GRID CONTROL

FITS STANDARD MOUNTS

Increases Distance-Clearness-Selectivity and Volume

YOUR SET DESERVES ONE

PROGRESSIVE DEALERS

are finding TURN-IT Grid leaks selling in ever increasing numbers. There is an active demand for grid-leaks—and the TURN-IT meets every demand. Write for details.

20 So. 15th St. PHILADELPHIA

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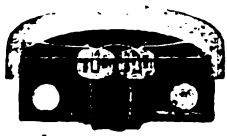
Just like being there yourself

JUST like being in the same room—when your favorite violinist plays. You miss none of the wizardry of his art, if you listen-in with Murdock Radio Phones. You get it all—the rich resonance of the high and low notes and the subtle shading of the softer tones. Everything is reproduced clearly and with wonderful volume.

Perfect construction and diaphragm adjustment the reasons

The powerful magnets in the Murdock build up volume signals—and the sensitive, perfectly adjusted disphragms turn these into clear, natural tones.

The seating and clamping of the diaphragms is an outstanding feature of the Murdock. This adjustment prevents distortion due to vibration.



Built, not assembled

Murdocks are made in a single unit, of superior moulded insulation. Each part is fitted by one process into its proper place. They are moulded together—assuring firmness, strength and durability. And they can't get out of adjustment.

May be worn for hours without discomfort

The Murdock may be worn through a whole evening without fatigue. Ear caps are moulded to fit the ears and exclude outside noises. The improved flat headband is feather-weight and does not bind the head; and there are no screws to entangle the hair.

For 20 years Murdock has been making radio phones of high efficiency. Over 1,000,000 users have accepted the Murdock standard of quality and price as the best measure of radio phone value. Buy a Murdock today and test it out—if you want to get the best results from your receiving set. They are fully guaranteed.

SEND FOR FREE BOOKLET. Mail coupon to us and we will send you our helpful booklet, "The Ears Of Radio." It explains in detail the importance of radio phones to efficient radio reception.

MURDOCK MULTIPLE PLUG JACK. This effective plug jack permits the use of one to four 'phones at the same time. Get one.

Announcing the Murdock five tube Neutrodyne Set. (Illustrated above). See this new type at your dealer's. Wm. J. Murdock Company, 371 Washington Ave., Chelsea Mass., Branch Offices: Chicago and San Francisco.

MURDOCK RADIO PHONES

Standard since 1904

WM. J. MURDOCK CO.
371 Washington Avenue,
Chelsea, Mass.

Gentlemen: Please send me, without obligation, your free booklet, "The Ears Of Radio."

Name.....

City.....

State.....

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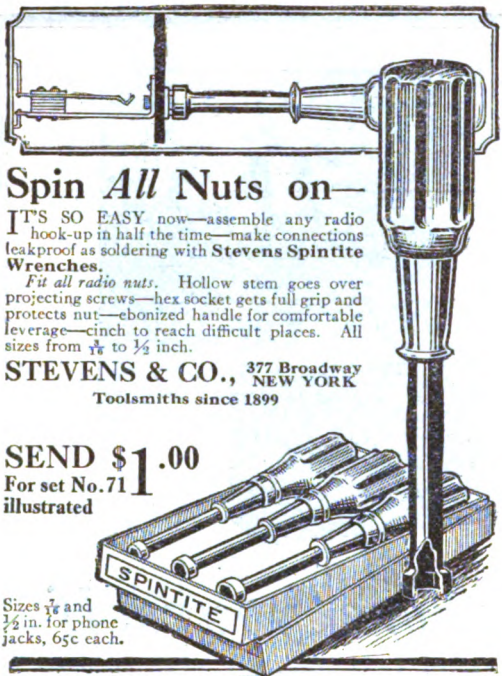


Spin *All* Nuts on—

IT'S SO EASY now—assemble any radio hook-up in half the time—make connections leakproof as soldering with **Stevens Spintite Wrenches.**

Fit all radio nuts. Hollow stem goes over projecting screws—hex socket gets full grip and protects nut—ebonized handle for comfortable leverage—cinch to reach difficult places. All sizes from 5/16 to 1/2 inch.

STEVENS & CO., 377 Broadway NEW YORK
Toolsmiths since 1899

SEND $1.00
For set No. 71 illustrated

Sizes 1/16 and 1/2 in. for phone jacks, 65c each.

Stevens SPEED UP TRADE MARK *Tools*

Sterling

PORTABLE RECTIFIER

"The Battery Charger Without a Weakness"

AN old stand-by made according to latest radio improvements. A 5 amp. maximum charging rate. Number of contacts reduced to one. Freezing and sticking eliminated. Quiet in operation. Almost total absence of sparking. Connect to any 110 volt A.C. lighting circuit. Cannot be used incorrectly nor harm plates.

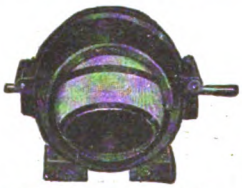
THE STERLING MFG. COMPANY
2843 Prospect Ave., Cleveland, O.

$16.00
West of Rocky Mountains $17.00

Save $2

—probably more, by using R.P.C. famous

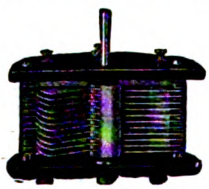
NON-MICROPHONIC
You Cannot Hear Them During Tuning



MOULDED BAKELITE VARIOMETER, $5.00

Scientifically accurate for long distance tuning. Moulded of Mahoganite Bakelite.

Non-Microphonic!



23-PLATE CONDENSER $1.50

Affords precise calibration at all wave lengths. Mechanically rugged. Electrically correct.

Non-Microphonic!

"Guaranteed to Satisfy"

RADIO PRODUCTS CO.

Westport, Conn. U. S. A.

Distance & Volume

are found in

RayCoils

RayCoils "A" for Reinartz, Ray Coils "B" for RCS and Ultra Audion Circuits, RayCoils "C" for RCS, Ultra Audion and Tuned Radio Frequency for All Circuits. RayCoils "D" for Neutralizing Circuits 4 & 5 Tubes.

A = $2.50
B = 2.00
C = 2.00
D = 2.00

Use the RCS Circuit with or without Radio Frequency for Simplicity in operation and results. Not equalled by any set for volume and distance.

Coils in Separate Box With Wiring Diagram

Working **Blue Prints** of four sheets 12 x 18 of all standard circuits, such as The Variometer, Reinartz, RCS one and three tube sets and five tube Neutralizing Circuit 50 cents a set.

We also carry a complete line of Carter, Howard, Kellogg, All American and Trimm parts.

If your dealer cannot supply you, we will mail direct.

R. C. SCHOONHOVEN
Major Q. M. R. C.
ELGIN, ILL.

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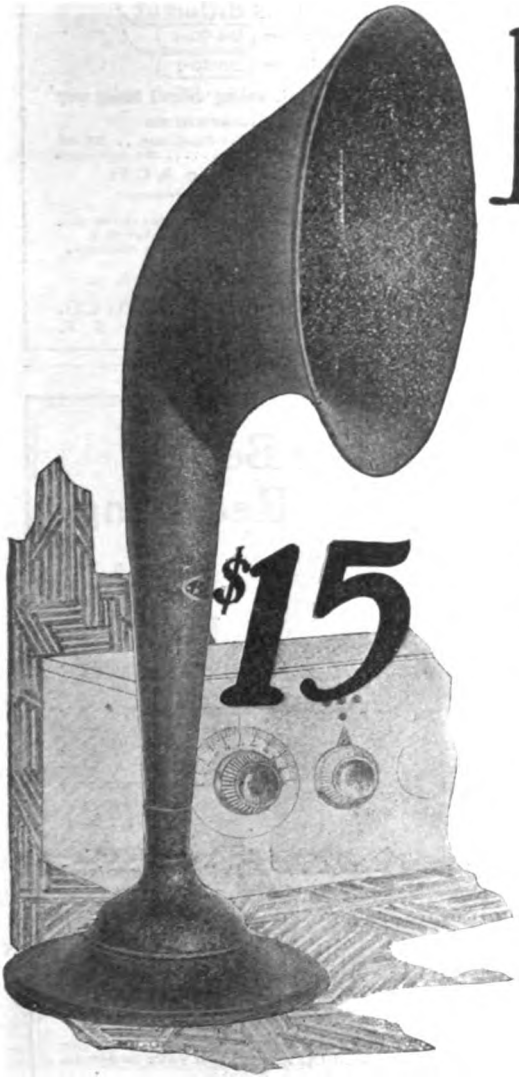
Perfectone

TRADE MARK

RadioReproducer



Listen in—home folks

Enjoy radio broadcast music and voice as faithfully reproduced with a Perfectone, the connecting link between radio broadcasting and its satisfactory interpretation in the home.

As the name implies, its perfect tone enables the radio audience to visualize the performers and to feel their presence.

The Perfectone has volume beyond the merrymaking of your guests, yet its tone may be softened by an adjustable volume-control feature.

The Perfectone is pleasing in appearance, and when used with a Neutrodyne, Regenerative, or in fact any tube set of sufficient energy, gives remarkable reproduction.

Before you purchase a loud speaker at any price, listen to the Perfectone.

PERFECTONE
RADIO CORPORATION
490-C Broome Street
New York

BROADCASTING IS THE UNIVERSAL STAGE—YOUR ARM CHAIR A BOX SEAT

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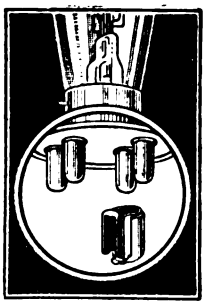
RADECO Safety Fuses



Are protecting countless Radio Tubes

DEALERS

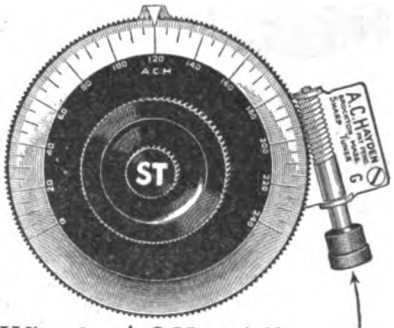
Add this profitable sales maker to your line and make satisfied customers. If you are not handling this fast selling specialty write us at once.

RADIO EQUIPMENT CO.

New England's Oldest Exclusive Radio House

20 Stuart St. Boston, Mass.

A Pleasant Surprise Awaits the User of the A.C.H. Sharp Tuner Dials



Why the A.C.H. is different

3 in. DIAL ➠ ACH ➠ 156-to-1

4 in. DIAL ➠ ACH ➠ 215-to-1

Will improve any receiving set, making difficult tuning easy

Money Back Guarantee

Price 3-inch size....$2.50 Price 4-inch size....$3.00
Regular fitting 5/16 shaft ¼ and 3/16.....5c each extra

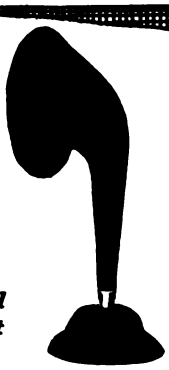
Extra Advantage of the A C H

1. Can be attached or removed from any instrument.
2. Rough tuning same as any dial.
3. Movement so fine that the eye cannot detect but the ear can.
4. Automatically locks instrument so no jar can disturb it.
5. Dial grounded reducing the body capacity to a minimum.
6. Special dial 2 graduations where ordinarily one.

MAIL ORDERS SENT PREPAID IN U. S. A.

A. C. HAYDEN RADIO & RESEARCH CO.
25 E. Battle St., BROCKTON, MASS., U. S. A.

$8



A phone plus a FIBERTONE makes a beautiful musical instrument

The highest tonal quality undisturbed by either metallic noises or distortion is best obtainable with a fiber horn. This one factor is the reason for Fibertone's popularity. And the low price for such fineness is a sensation of the radio world. The beautiful crystalline finish of the Fibertone fits it for any place where the finer things of the home are seen.

If your dealer cannot supply you write direct.

FIBER PRODUCTS COMPANY
34 Orange St. Bloomfield, N. J.

FIBERTONE

RADIO HORN

For Better Receiving

Elgin Precision Condensers

Accuracy in your condensers means better results in your receiving. Elgin Precision Condensers are accurate. Permanent accuracy and rigidity are built into them.

Fully Guaranteed

Size	Capacity	Plain	Vernier
3 Plate	.000063 M. F.	$1.75	$—
11 Plate	.00025 M. F.	2.40	4.00
17 Plate	.00035 M. F.	2.75	—
23 Plate	.0005 M. F.	3.00	4.50
43 Plate	.001 M. F.	4.00	5.50

3" diameter composition dials, 50c extra

See your local dealer. If he cannot supply you send his name with your order to

The Elgin Tool Works, Inc.
69 N. State St., Elgin, Illinois

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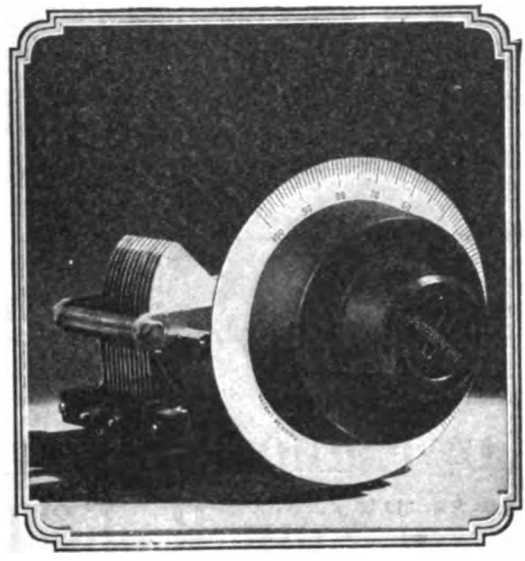
Controlled Reception



Tune out Local Interference

The Accuratune is not a mere dial, but an actual micrometer tuning control ten times more efficient than various tuning devices. With any good condenser, the Accuratune action is so precise that local stations can be tuned out completely, and station after station brought in that you never received before.

Even a person with little knowledge of radio can easily tune a receiver with the precision and accuracy of a radio amateur.

The Accuratune is designed for both coarse and fine tuning without the use of vernier attachments. Fits standard condenser shafts.

This unusual tuning efficiency amply repays you for the slight addition in cost over ordinary dials. Price $3.50.

THE MYDAR RADIO COMPANY

9-B Campbell Street, Newark, N. J.

ACCURATUNE

MICROMETER CONTROL

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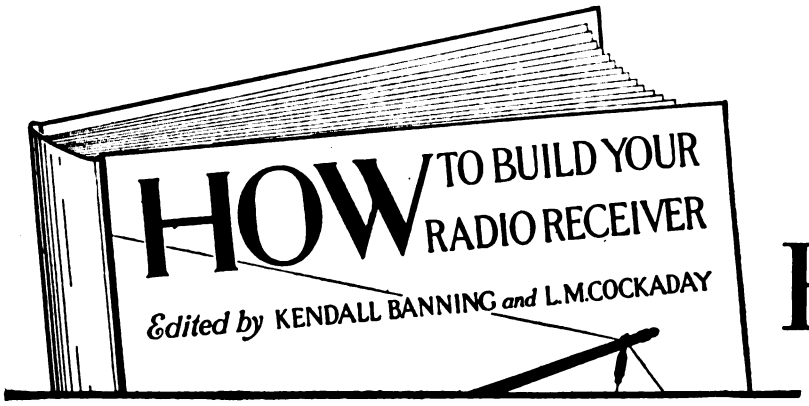

This Big 100-Page Handbook FREE

They're Going Fast!

Popular Radio's New Book "How to Build Your Radio Receiver"

The most complete and authoritative collection of material yet published in book form on how to build and operate various types of radio receiving sets

THE first edition of POPULAR RADIO'S new 100-page handbook, edited by Kendall Banning and Laurence M. Cockaday, is fast becoming exhausted. It can be *given away free*, for only a limited time longer.

So great has been the demand for this new handbook, "How to Build Your Radio Receiver," since its publication was first announced, that now after only 60 days it is necessary to plan for a second printing.

Therefore it is very doubtful how long this most liberal introductory offer can be held open.

This book is the most comprehensive and valuable contribution of its kind ever published for the radio enthusiast who, *with or without previous technical knowledge or training*, wishes to construct a radio receiving set of his own that will meet his every requirement.

"How to Build Your Radio Receiver" gives complete specifications for the construction of *seven* separate and distinct receiving sets—covering the most amazing range and variety of circuits, from the most modern simple crystal set to the famous Super-heterodyne (see opposite page).

All working details are given—the list of parts required and their approximate cost; complete hook-ups and circuit diagrams and *how to read them;* illustrations making all points clear, and simple instructions on how to assemble, mount, wire and operate each set.

Nor have any helpful pointers been omitted. In this new book edited by Mr. Banning and Mr. Cockaday, you will also find scores of valuable hints and suggestions about aerials, how to select your parts, how to install your set, tips on tuning, and how to learn the code.

In all, a book you will not want to be without—one that will be worth many dollars to you. Yet, if you act at once, it will not cost you a penny. We will send you a copy of this valuable handbook absolutely free with a year's subscription to POPULAR RADIO at $3.00. If you are already a subscriber, you may renew or extend your subscription for an additional year and still secure one of the first copies of this valuable book *absolutely free.*

The Coupon printed at the bottom of the opposite page provides a convenient means for you to secure this big cloth-bound handbook free. But you must act quickly!

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Seven Remarkable Receiving Sets

Illustrated *Diagramed* *Described*

EACH of the sets described in POPULAR RADIO'S new book has been selected as the most *ideal* of its kind—for distance, selectivity, tone, volume, simplicity of construction, ease in tuning, reliability and general all-around satisfaction.

You will find sets employing both crystal and vacuum tube detection, with regenerative amplification, audio-frequency amplification, "push and pull" power amplification, radio-frequency, *compensated* radio-frequency and *intermediate wave* radio-frequency amplification.

You have your choice of crystal, one-tube, three-tube, five-tube, six-tube or eight-tube sets—the broadest selection anyone could ask for, all clearly illustrated, charted and explained in the simplest possible terms.

Here are the actual receiving sets described in this new book, "How to Build Your Radio Receiver":

A $5 Crystal Set

The simplest up-to-date set for local broadcast reception. Approximate range, 15 miles, though distances up to 400 miles are not extraordinary. Gives clear signals on headset without distortion. No operating cost whatever.

The Haynes Single Tube Receiver

An efficient set that may be made by a novice at an approximate cost of only $15 for parts. Simple to tune, selective, good audibility. Long distance range up to 1,000 miles on earphones. Six-volt storage battery and 22½ volt "B" battery required, or may be adapted for dry cells and dry cell tubes.

A Two-Stage Audio-Frequency Amplifier

This instrument may be added to *any* set, crystal or tube, to strengthen the received signals so that they will operate a loud speaker. It is easy to construct, efficient, and costs only about $15 for parts. Operates on the same "A" battery that is used on the vacuum-tube detector unit.

The Cockaday 4-Circuit Tuner

A 3-tube set, famous for its high selectivity and beautiful tone. So neat and compact that it may be kept in a bureau drawer. Cost of parts about $40. Receiving range approximately 1,500 miles on a loud speaker. Operates on 6 volt storage battery and two 45-volt "B" batteries, or may be adapted to dry cells and dry cell tubes.

A 5-Tube Tuned Radio Frequency Receiver

Two stages of tuned radio-frequency amplification, detector, and two stages of audio-frequency amplification are here employed so that the possibility of "oscillation and re-radiation" is eliminated. The set can be operated on a loop antenna and may be built at a cost of only $80 for parts. Six-volt storage battery and two 45-volt "B" batteries required. Range about 1,000 miles on loop or indoor antenna, and 2,500 to 3,000 miles on an outdoor antenna.

The "Improved" Cockaday 4-Circuit Tuner

Probably the most important contribution yet made to the equipment of the radio fan. A compact 5-tube set with a receiving range of over 3,000 miles. Cost of parts about $70. Wavelength range from 150 to 675 meters. Automatic tuning and power amplification. Maximum volume of sound, excellent reproduction and no interference. Requires a 6-volt "A" battery, three 45-volt "B" batteries, one 22½-volt "B" battery and a 9-volt "C" battery.

The Regenerative Super-heterodyne Receiver

More sensitive, more selective and more simple to tune than any other 6-tube receiver yet developed. A three-section, 6-tube set employing the Haynes Single Tube Receiver as tuner. May be further extended to a four-section, 8-tube set by the addition of the two-stage audio-frequency amplifier. The cost of parts approximate $65. Range of 3,000 to 4,000 miles on a loud speaker. Has been called the "Rolls-Royce" of radio receivers.

¶ As a special introductory offer, for a limited time only, this book will be given FREE with a year's subscription to POPULAR RADIO at $3. Simply mail your remittance with the handy coupon below, and a FREE copy of "How to Build Your Radio Receiver" will be sent you, postage prepaid. Your subscription will be entered at once.

This Coupon Entitles You to a Free Copy

POPULAR RADIO, Dept. 35,
9 East 40th Street, New York City.

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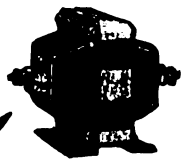
Amplify the MODERN way!

"Push-Pull" Amplifying Transformers



for those who demand more than has heretofore been secured from audio frequency amplification. Used in addition to one or two stages of audio. When used as second stage, quality of tone is considerably clarified with no perceptible increase in volume, but with distortion due to harmonics entirely eliminated. Used as third stage, tone and quality of reproduction are not only improved but amplification is also greatly increased.

Two Modern "Push-Pull" Transformers and two standard amplifier tubes, preferably of UV-201-A or C-301-A type are necessary for one stage of "Push-Pull" amplification. This is used in connection with a one or two stage standard audio frequency amplifier. For the most satisfactory operation a separate "B" battery of 90 to 112 volts is used. All information and wiring diagrams sent upon request.

Modern Standard Audio Transformers

are also made in 4 to 1 and 10 to 1 ratio. The 4 to 1 is recommended for use for 2-stage amplifier. The 10 to 1 is especially recommended for all reflex circuits where a higher secondary reactance helps maintain the equilibrium in the circuit necessary for effective operation. The audibility amplification curves of these transformers are practically flat. Modern Standard Transformers are guaranteed to give perfect satisfaction. Can be used with all standard tubes.

If your jobber or dealer can't supply you, write us giving his name.

The Modern Electric Mfg. Co.
Dept. 703 Toledo, Ohio

Trade Mark

LOUD SPEAKER $18.50

HEAD SET $4.50

"ROYALFONE"
KING OF ALL

A complete loud speaker of superior qualities. Will reproduce music or speech with no distortion.

No extra batteries required. Will operate at one or more stages of amplification.

Comes complete with 6 foot cord. 24" high—14" bell—Crystaline Finish.

A highly sensitive pair of receivers for the amateur or professional — for long distance or local broadcasting, also very comfortable.

Royal Electrical Laboratories
Dept P. R., Newark, N. J.

Royalfone
KING OF ALL

FROST-RADIO
Ask Your Neighbor

FROST-FONES

No. 161 FROST-FONES. Drawn aluminum shells and composition caps. 2,000 ohm, Special head band **$4.00**

No. 171 FROST-FONES. Same as No. 161, aluminum shell type, but 3,000 ohm **$5.00**

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No. 172 FROST-FONES. Genuine maroon moulded BAKELITE shells and caps with moulded in terminal block and special improved design. 3,200 ohm . **$6.00**

Your neighborhood dealer handles FROST-RADIO

HERBERT H. FROST, Inc.
154 West Lake Street
CHICAGO
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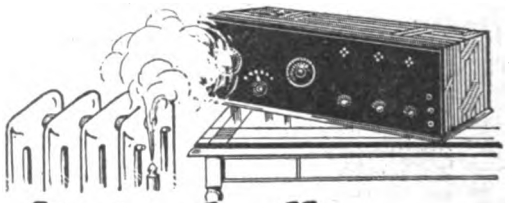

It stands all kinds of abuse

This incomparable radio panel material never changes its shape or super-resistant qualities. It cannot warp, swell, melt, shrink or split. It is absolutely unaffected by water, oil, steam, heat, cold, solvents, high voltage ozone or any weather condition.

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(A Laminated Phenolic Condensation material)

Makers of the highest type radio apparatus are partial to panels of Bakelite-Dilecto. Builders of home-made sets, too, use this material to achieve surpassing results. Tremendously tough yet not hard to machine. Dealers will show you how to get it cut and drilled.

THE CONTINENTAL FIBRE CO.
Factory: Newark, Delaware

Services on Bakelite-Dilecto (also Continental-Bakelite, Conite, Contex and Vulcanized Fibre) from

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The RADIOCEIVE
Loud Speaking Unit

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Thousands of delighted users, with many individual repeat orders.

Can be adapted to fit all the leading Horns and Phonographs.

Latest Model complete with 5 foot cord and rubber coupling. Price **$4.00**

"Showing Unit in horn, using Rubber Coupling.

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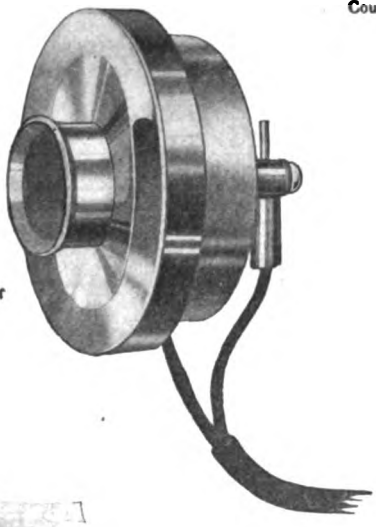
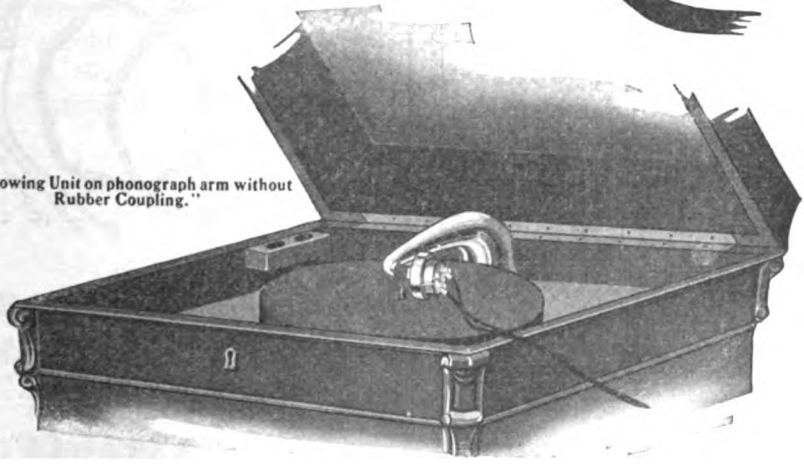
Specialists in the Manufacture of Headsets and Loud Speaking Units

369 Jelliff Avenue, Newark, N. J.

"Unit complete. Can be used with or without Rubber Coupling."





"Showing Unit on phonograph arm without Rubber Coupling."

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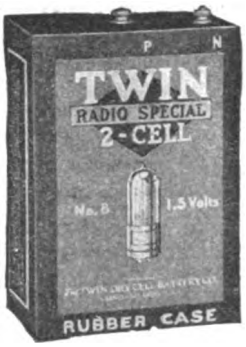

"Crammed full of Electrical Energy"

The No. 8 Twin Radio Special is the last word in dry battery development to insure long lasting service on radio apparatus.

Increased capacity insured by large internal zinc plate construction. Also positive assurance of voltage maintenance.

By placing the zinc on the inside of a rubberized container, maximum exhaustion of materials is secured. It is the lowest priced two cell battery on the market and will deliver three to five times more service than single round cells.

TRY IT AND BECOME CONVINCED

If your dealer cannot supply, sent postpaid 95c each.

THE TWIN DRY CELL BATTERY CO.
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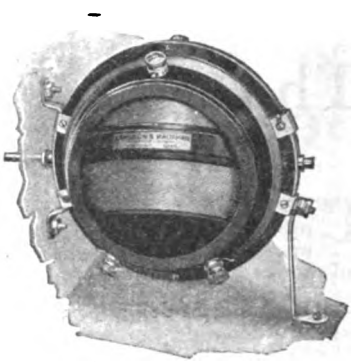

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A variable radio frequency transformer

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LANGBEIN & KAUFMAN

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FOUR CIRCUIT COIL SET

$2.50

"A" Coil covered square wire.

"D" Coil bank wound.

Full set A, B, C and D coils made exactly according to Cockaday's specifications. Full size blue prints and illustrated instructions with each set.

Materials for standard Four Circuit Tuner— panels, coils, condensers, verniers, grid leak, vernier rheostat, socket, jack, dials, switch, contacts, posts, busbar wire, spaghetti, etc. (no tubes or phones).

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IMPROVED TYPE COILS

Double silk covered wire on Bakelite tubing per set $4.00

Complete materials for 5 tube improved Cockaday set $58.75

All parts in stock. Get our price list.

Postage additional on all orders.

Send no money. Order by post card, pay the postman.

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HELENA, MONTANA

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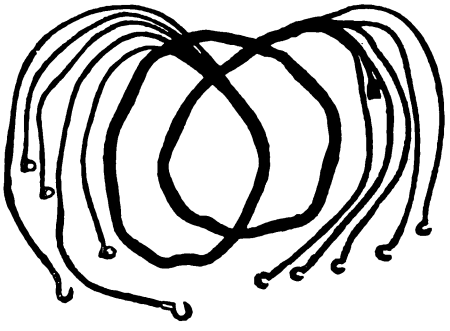
BATTERY CONDUIT



Cat. No. 106 . . $1.20

Contains 5 separate cables. Each cable is made of flexible copper wire, 16 gage, rubber and braided cotton covering, and the five are covered with braided cotton insulation. Each wire is coded, 2 for "A" bat., 3 for "B" bat.

R. MITCHELL CO.

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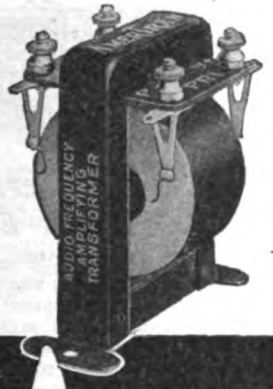

Type AF-6
Turn ratio, 5:1

Improve your set with an AmerTran

—STANDARD of EXCELLENCE *for* AUDIO AMPLIFICATION

AMERTRAN

TRADE MARK REG.U.S. PAT.OFF.

OVER twenty years ago this organization equipped the stations of the Marconi Company with the large transmitting transformers for the first commercial trans-atlantic wireless communication.

The 22,000-volt transformer now doing duty at Radio Central, Rocky Point, L. I., is one of our latest installations.

This long experience in transformer design and construction has produced the AmerTran.

Its flat-top distortionless amplification curve assures a pure tone rendering of the full musical scale.

It amplifies in one stage from 30 to 40 times in the flat part of the curve, depending on the tube constant—the amplification is approximately 5 times the tube constant.

At your Electrical Dealer's, or
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Send for Circular No. 1005

American Transformer Company

Designers and builders of radio transformers for over 22 years

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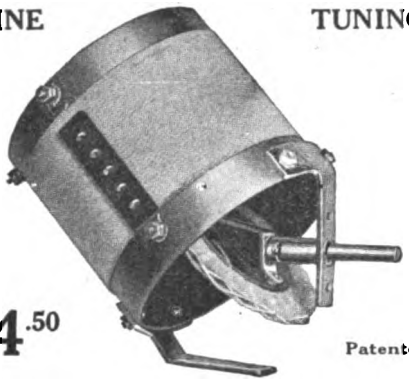

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The New Hartman Variocoupler *with* Spider Web Rotor

Its small size saves panel space. Clearer reception and maximum efficiency insured. Dead shaft has no capacity effect in tuning. Pig Tail contacts; no live brackets. If your dealer can't supply you, write us.

The Hartman Electrical Mfg. Co.
33 East 5th Street, Mansfield, Ohio

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Try This Perfected Loop AT OUR EXPENSE

Picks out just the station you want. Reduces reradiation and interference. Fits into the smallest space. Entirely enclosed by Bakelite Shields with binding posts for various circuits. Send a postal, specifying the type you want to try. The money you pay the postman may be refunded anytime during the 10 days you try it out. Doesn't cost you a nickel unless you find it what you want. No trouble at all. Just drop a postal NOW!

Type A-737 (300-700 meters) 6 inches square—non-directional.....$10
Type A-7236 (176-1000 meters) 6 inches square—non-directional.....$12
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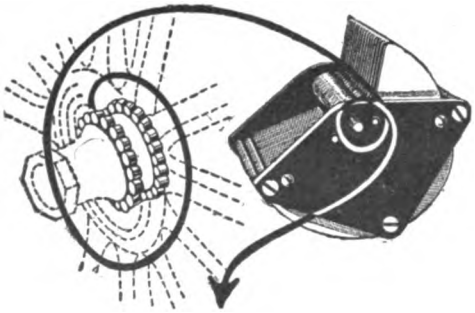
V-DE-CO RADIO MFG. CO., Dept. F. Asbury Park, N. J.



True Running Bearings For the Lasting Accuracy Of U.S. TOOL CONDENSERS

An automobile is easy to steer and wears out tires the least, when its wheels run true. U. S. Tool Condensers are **lastingly accurate** and turn easier for the same reason—**precise bearings.** **U. S. Tool Condensers** are right in every detail. A new condenser for any one that is unsatisfactory.

Perfect Insulation of LAMINATED CONDENSITE CELERON End Plates.

Write for Booklet!

U. S. TOOL COMPANY, INC.
116 Mechanic St. Newark, N. J.

Which Aerial—Wire or Ribbon?

YOUR Aerial is a part of your Receiver! Don't blame your set for unsatisfactory results. Nine times out of 10 the fault is in the Aerial. Try the sensational new TRANSCONTINENTAL "Ribbon" Aerial—adopted by Radio Engineers, broadcasting laboratories, and thousands of enthusiastic radio fans. It's guaranteed to give clearer tone, bigger volume, greater distance, sensitiveness and selectivity or **money refunded.**

500% better results with the sensational

TRANSCONTINENTAL Ribbon COPPER AERIAL

$1.50 FOR 50 FOOT COMPLETE

75 ft., $2.25
100 ft., $3.00
150 ft., $4.50
Complete, ready for use with soldered snap hooks to fasten on to insulators.

weather proofed! to resist corrosion. Based on scientific principle that broad surface increases receptivity and amplifies the tone. Equally satisfactory with tube or crystal sets. "Twist it!" says FORREST, the famous radio expert. "2 twists per 50 feet catches waves in all directions." **Order from this ad!** If your dealer will not supply you promptly. Postage paid when cash with order, or C. O. D. plus postage. Now sold in good radio stores, all over the U. S.

DEALERS and AGENTS! Write for attractive propositions today! Big sales, good profits sweeping the country so get busy.

ACORN RADIO MFG. CO.,
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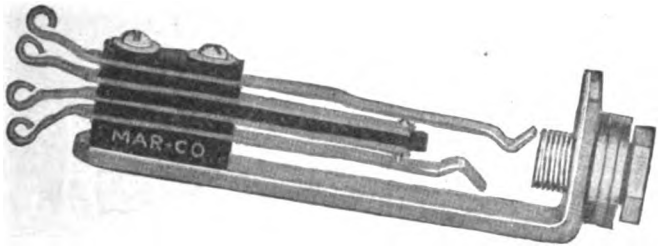
The Mar-co Shur-Grip Jack



GIVE YOUR SET A BETTER CHANCE TO MAKE GOOD

GOOD WIRING MEANS HEAVY WIRE

You can easily connect heavy wire to the special loop terminals on

MAR-CO SHUR-GRIP JACKS

Once wired into a circuit sturdy springs grip the plug, rugged sterling silver contacts carry the current. No better radio jacks exist.

Made in eight styles. All insulated with formica. Finely finished and moderately priced.

See them at your dealers

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Smallest In Size Greatest In Results

$3.50

½ Actual Size

Premier "HEGEHOG" Audio TRANSFORMER

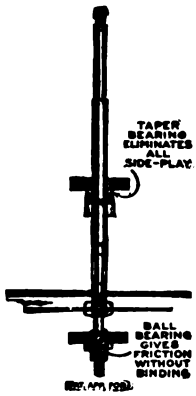
The wonder of the Radio world. A more efficient transformer than you could ever buy before. And the smallest, most compact instrument of its kind. About the size of an English walnut and yet "HEGEHOG" is a wizard for reproduction volume, tone quality and consistent performance. Less distortion. No foreign noises. The secret is in its patented construction. It is shielded 100%. Fully guaranteed. Ratios 1 to 3, 1 to 4, 1 to 5—$3.50; 1 to 10, $4.50. You'll want "HEGEHOG" in your next "hook-up," so get all the facts NOW. Our Free Bulletin No. 92 gives them fully. Send for it.

Ask for and insist on "HEGEHOG" at your dealers

Premier Electric Company

3807 Ravenswood Ave., CHICAGO

For Sturdiness and Accuracy Use Lombardi Condensers



A rugged condenser built on an entirely new principle, made to last a lifetime. The tension is adjusted by tightening a thrust plug causing the proper tension between a hardened steel ball and a 45 degree tapered brass bushing.

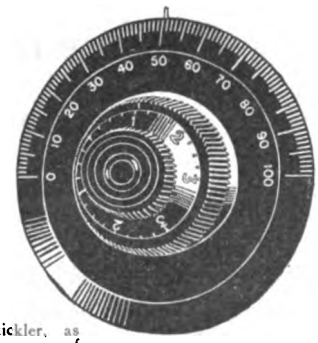
Also makers of coils and sockets.

Literature and prices furnished upon request

Lombardi Radio Mfg. Co.

67 MINERVA ST. DERBY, CONN.

The **"EZTOON"** **(Easy Tune) Radio Dial**



is two dials in one with a 40 to 1 ratio.

"EZTOON" dials make possible vernier adjustment of vario-coupler, variometer rheostat, potentiometer, or tickler, as well as saving the expense of a second set of adjustable plates on condensers.

The "EZTOON" gives unusual close tuning so essential in Heterodyne, Acmedyne, Neutrodyne and tuned radio frequency circuits.

No panel holes to drill. Just take off old dial, slip on "EZTOON" dial and tighten set screw.

Sold under positive money-back guarantee.

Ask your dealer. If he cannot supply you, we ship parcel post 3" dial, $2.00; 4" dial, $2.25. Jobbers — Dealers — Manufacturers: Write for discounts.

With "EZTOON" (Easy Tune) RADIO DIAL You Can

bring in stations that heretofore you have passed up as impossible.

Get and hold stations

Use it on any and all types of receiving sets to obtain vernier adjustment unobtainable before.

Tune in DX stations you never heard before.

Obtain vernier adjustment of all tuning instruments within your set.

BUTLER MANUFACTURING CO.

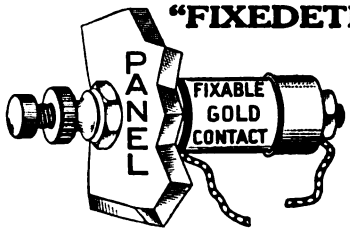
3236 W. Washington St., Indianapolis, Ind.

THE REFLEX

"VARIOTECTOR"

Fits Cup or Panel $1.50 **Crystal "Refills" 50c**

"FIXEDETECTOR"



Like above, but permanently adjusted

$1.25

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TRIPLE SIZE—TRIPLE LIFE— TRIPLE POWER—

Single Pyrite or Galena, 75c
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"Vario-tenser" Gold-Brush Contact, 50c
Guaranteed by Dealers Everywhere

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102 N. 19th St. Phila.

Mineral Pioneers for Nearly 50 Years

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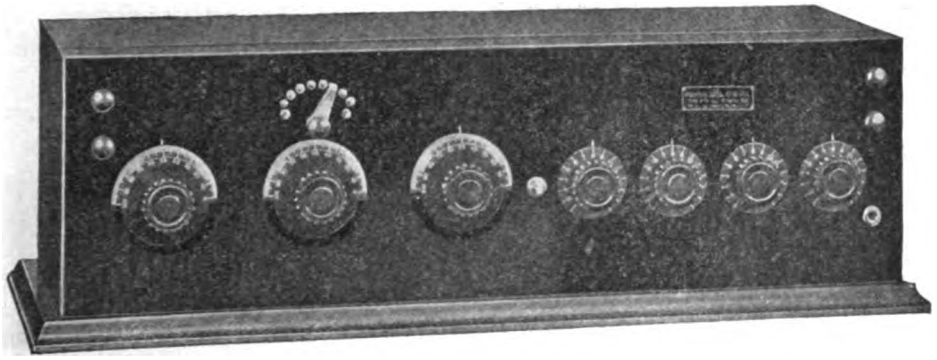

Broadcast Receiver — Type R-12

Employing special Copp VARIO-SELECTOR constructed on Copp Circuit No. 5.

This Receiver combines Tuned Radio Frequency with a special selector device which gives to this set the requirements necessary for perfect radio reception:

Selectivity Volume Clearness Distance Ease of Tuning

Wave Length Range — 200 to 600 meters
Distance — up to 2500 miles

Type R-12 is a 4 tube Set designed for satisfactory use at a reasonable price, both for cities where the nearness of Broadcasting Stations requires fine selectivity; as well as for suburban districts where selectivity is not as essential as clearness, volume, distance and ease of tuning.

The VARIO-SELECTOR makes this set efficient for either Sharp or Broad tuning as conditions warrant.

Broadcast Receiver Type R-12 is built of the highest grade materials using Bakelite insulation throughout, all contained in a beautiful Brown Mahogany finished Cabinet.

Copp Circuit No. 5 is the fifth proven circuit developed and perfected by our Engineering Department under the direction of Mr. R. S. Copp, who built and perfected the first single circuit regenerative Receiving Set, known as Copp Circuit No. 1.

Full information, with descriptive literature, etc., will be mailed on request.

The Price of Type R-12 . . . . . $98.00
(Without Tubes)

The A-C Electrical Mfg. Co. - - Dayton, Ohio

Makers of Electrical Devices for over 20 Years

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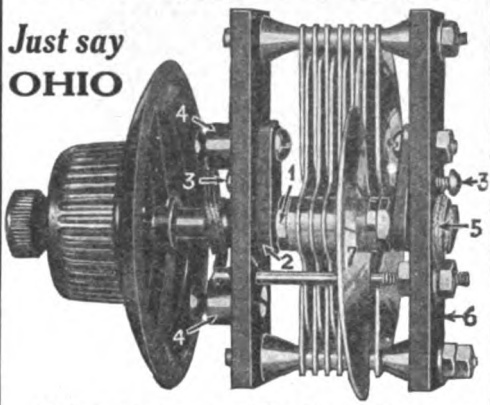
CONDENSERS?

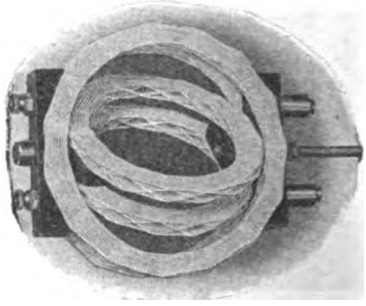
Just say
OHIO



Made in a factory devoted to the construction of condensers exclusively, Ohio instruments are designed to give absolute precision. Notice the cone-shaped adjustable bearings that insure smooth running. Mounting lugs are insulated permitting shielded mounting without any losses. Rotor is double bonded for perfect conductivity.

The Ohio Condenser is a quality condenser and is fully guaranteed. Dealers, jobbers and distributors, write for our proposition if you want your customers to have the best.

Harvey and Walton Mfg. Co.
30 E. Front St. Cincinnati, O.



Performance

The performance of the R. M. C. Variometer equals its exceptionally neat and attractive appearance.

Seven-eighths of windings are in mid-air thus reducing dielectric losses to a minimum. Sickles Diamond Weave construction reduces distributed capacity to a minimum.

The R. M. C. Variometer has extreme maximum and minimum variation. The Variocoupler is the same size and general construction and works remarkably well in Reflex or other circuits requiring a first-class variocoupler.

Licensed under basic patents
Other patents pending

Variometer	**$4.50**
Variocoupler	**4.50**

Ask your dealer to show you these R. M. C. products.
Immediate deliveries to jobbers and dealers.

The Radio Manufacturing Co.
Springfield, Mass.
Dept. B **337 Worthington St.**

$5.50

Authorized Cockaday Coil

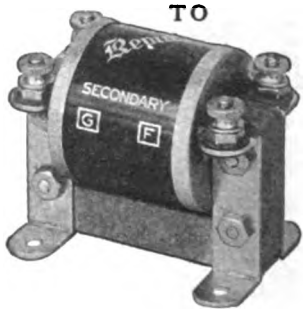
Scientifically built of hard rubber ⅛" wall, wound with double silk covered non-shellaced wire. Does not absorb moisture like ordinary coils. Gives low dielectric losses—low distributed capacity—low leakage losses—low conductor resistance. You get maximum selectivity, greater volume, sharper tuning, maximum sensitivity. Copper terminals, no loose ends. Built in strict accordance with specifications by L. M. Cockaday. Over twice as efficient as ordinary coils. Guaranteed. At your dealers, otherwise shipped to you postpaid.

Special proposition to dealers

PRECISION COIL CO., Inc.
209-B Center St., New York

TO

C H I C A G O



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On a Loudspeaker!

1. Mr. Hunter of Chicago heard Porto Rico on a loudspeaker using two Republic Transformers in a five tube Neutrodyne set.

2. Republic Transformers are made of highest grade materials, a silica steel core being used instead of cheap iron. Every instrument is carefully tested on broadcasting before it leaves the factory.

3. Although the price is low, the Republic Transformer is guaranteed to do anything a transformer of twice the price will do. If it fails to do so, money will be refunded without question.

4. They may be used with any kind of tubes for all stages of amplification.

Only $2.50

Order now—try it ten days.—If not as guaranteed return it

FLINT RADIO CO. **Chicago**
1772 Wilson Ave.
Discounts to Dealers

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A *Freed-Eisemann* KNOCKDOWN NEUTRODYNE RECEIVER

Unassembled Model KD-50
Freed-Eisemann Neutrodyne Receiver

NEUTRODYNE has taken the country by storm. It is *the* remarkable distance getting, powerful, non-oscillating and non-whistling receiver.

A 32-page book answers every question. The panel is accurately drilled. A baseboard is furnished; in fact, everything down to the very last screw and nut, including all necessary parts excepting the cabinet.

Besides the book there is furnished schematic blueprints and template for drilling the baseboard, also full-size pictorial perspective wiring diagram, so that it will hardly be possible for the amateur with ordinary care and skill to make an error.

Remember that here are licensed parts—not a collection of apparatus trusting to luck that they will assemble properly. Each part is *designed* and fitted to work with each other part in this particular set. The instructions are so complete and the parts so accurately matched that you will be grateful for the manner in which we have eliminated guess work in the amateur construction of this receiver.

For sale by dealers of the better class throughout the country, for amateur and experimental building. Builders are cautioned against attempting to build a Neutrodyne Set with parts which are not recommended and designed by the manufacturer to work with each other.

NOW the opportunity is presented to obtain a complete set of parts, recommended by the manufacturer, to work with each other in building your Neutrodyne set. An illustated 32-page book on how to build the Neutrodyne with full-sized diagrams and templates included.

Complete
With full Instructions

$80

Dealers Write for Name of Nearest Distributor

Front View KD-50
Neutrodyne Being Assembled

32-page illustrated book of instructions on "How to Build the Neutrodyne" with full size pictorial wiring diagram and full size panel and baseboard templates, $1. At your Radio Dealers.

Freed-Eisemann Radio Corporation

SPERRY BUILDING MANHATTAN BRIDGE PLAZA BROOKLYN, N. Y.

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New Model

"4-WAY" SWITCH PLUG : :

At Your Dealer's

$1.50

Switch on Loud Speaker or Phones by turning dial without removing Plug from Jack. Two Head Sets may be used if preferred or both Loud Speaker and Head Set AT THE SAME TIME

The new 1924 model "4-Way" Switch Plug embodies many improvements, making the manipulation much easier. The improved Spring Locking Terminal Connections are far superior to binding screws. They form permanent electrical contacts which never work loose, as binding posts are apt to do.

New SINGLE Radio Plug—

50c ***—the finest yet produced***

—employing our positive spring terminal connections that have proved so successful in our FOUR WAY PLUG—never works loose.

These remarkable plugs for sale by JOBBERS and DEALERS thruout the country

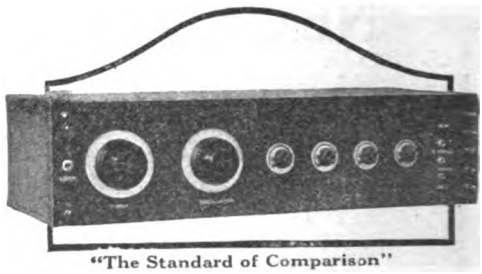
FOUR WAY CO.

Myrick Bldg., Springfield, Mass.

ULTRADYNE

The Improved

SUPER-HETERODYNE



"The Standard of Comparison"

Super-Selective

The ULTRADYNE is a simplified and improved Super-Heterodyne, employing the "Modulation System," an entirely new principle in radio reception just developed by R. E. Lacault, A.M.I.R.E., who spent four years in research work in the Radio Division of the French Signal Corps.

This new principle is of such a nature as to increase the sensitivity of the set over that of any known receiver—reduces to a minimum the controls employed, making the set easier to tune. Weakest signals are made to operate the loud speaker, because the "Modulation System" provides greater rectification.

The ULTRADYNE, in addition to the "Modulation System," incorporates every good feature of the Super-Heterodyne: SELECTIVITY—Completely cuts out all local stations at any time and receives distant ones clear and distinct. One degree variation of dial tunes out completely one station and brings you broadcasting never received before. SIMPLICITY—In tuning there are only two dials to adjust for all wave lengths. These are vernier dials, which can be calibrated for all stations. RANGE—Brings in distant stations that other receivers fail to get under the same conditions. Covers the whole broadcast wave length range.

Write for descriptive circular.

PHENIX RADIO CORP.

3-9 Beekman Street New York City

Send for thirty-two page illustrated book giving complete details on "How to Build and Operate the Ultradyne."

50c.

ULTRAFORMERS

Types "A" and "B" especially designed radio frequency transformers for use in the Ultradyne receiver.

Type "B" may be successfully employed in any super-heterodyne circuit as radio frequency transformers.

$5.00

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RECEPTRAD HAS REDISCOVERED THE SUPERHETERODYNE

THREE years have elapsed since the famous Superheterodyne circuit was first developed. Since then many have regarded the Superheterodyne as the most desirable circuit to use—but only to be attempted by the expert!

RECEPTRAD, after elaborate development and laboratory work has *rediscovered* the Superheterodyne for the layman—by its specially designed Heterodyne parts and easily followed construction helps.

You can now build a Superheterodyne without difficulty of any kind—regardless of your knowledge of radio or engineering. Thousands of miles on a loop! Volume so great you never use headsets to tune in. Distance vanishes before the Receptrad Superheterodyne.

The heart of the Superheterodyne is in its transformers. Receptrad has designed special intermediate frequency amplifying transformers which surpass in efficiency anything on the market—because they are built solely for the Superheterodyne. These transformers (Type 1716) have steel cores to assure power and stability. They cover a band of frequencies from 5,000 to 25,000 meters.

Type 1716 Transformers.....$8.50

Special Receptrad 8-Tube Superheterodyne Package:

- 1 Oscillo-Coupler, Type S W-21
- 1 Tuned Filter Coupler, Type H-34
- 3 R F-1716 Transformers—Range 5,000 to 25,000 meters.
- 1 Audio Transformer, Type ATX
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- 2 IMF By-Pass Condensers Type G-1000
- 1 SUPERHETERODYNE MANUAL

$55

JUST PUBLISHED! "The Superheterodyne Manual." This comprehensive book by Victor Greitt, A.I.E.E., I.R.E., is the only complete treatise on the subject of the Superheterodyne. 64 pages. Copious illustrations. Authoritative. Gives full instructions on HOW TO BUILD THE SUPERHETERODYNE SUCCESSFULLY with full size panel layouts, circuit details, etc. Price 1.50.

RADIO RECEPTOR CO., Inc.

57 BANK STREET **NEW YORK, N. Y.**

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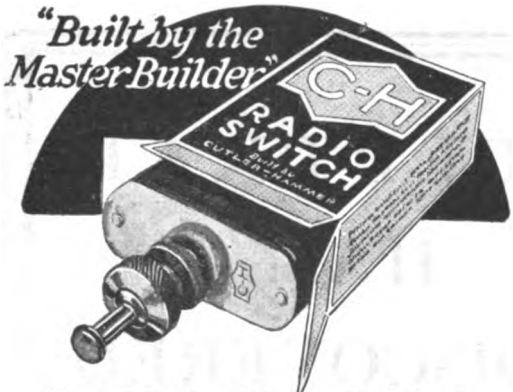

The perfect radio switch—correctly designed and skillfully constructed. Installed on any panel in five minutes to add hours of convenience, and protect both tubes and batteries. At dealers everywhere—insist on the genuine—in the orange and blue box. If your dealer has not been stocked send 60c plus 10c for packing, and you will be supplied direct.

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Member Radio Section
Associated Manufacturers of Electrical Supplies
Milwaukee, Wisconsin

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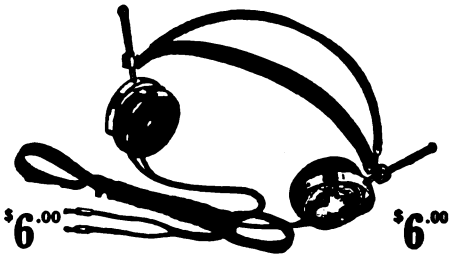
AMPL-TONE PHONES



A THREE DOLLAR
LOUD SPEAKER UNIT FOR HOME MADE SPEAKER
FREE
With Pair of Phones
Money Back Guarantee
Dealers Wanted

C. M. FRENCH MFG. CO.
SEYMOUR, CONN.

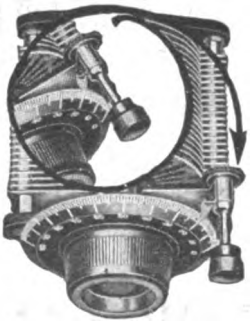
HEATH'S
Radiant Condensers
Established as Standard

The Electrical Testing Laboratories of New York have rated **Heath Condensers** at highest efficiency—"negligible series resistance." The secret is in the Heath process of stamping and tempering plates so that they are PERMANENTLY FLAT.

UNIQUE VERNIER

Separate geared adjustment reduced ordinary vernier tuning to infinite fineness.

Write for Illustrated Booklet and name of nearest Radiant Dealer.



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Vernier Type

All including 2⅞" dial and knob.

13 Plate, $5.00; 25 Plate, $5.50; 43 Plate, $6.50.

Jobbers and Dealers: Write Immediately for Proposition.

HEATH RADIO & ELEC. MFG. CO.
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Unity Rheostats

6 Ohms—Most Tubes
25 Ohms—201-A and 301-A
40 Ohms—199 and 299
Power Rheostats for Controlling Multiple Tubes.
$1.75 each—any resistance

Vernier

The highest type electrical instrument made for controlling resistance.

Recommended by all Scientists familiar with it, where close adjustment is desired.

Used in the Four Circuit Tuner.

"Hear a set that uses one"

Unity Cartridge Rheostat
with Single Hole Mounting

Interchangeable resistance Cartridges clip in without removing the Bracket from the panel.

Complete Rheostat $1.00
Complete Potentiometer... $1.60
Brackets only..... .60
Rheostat Cartridge only..... .40
Potentiometer Cartridge only... $1.00

Used on the "Long 45"

UNITY MFG. CO.
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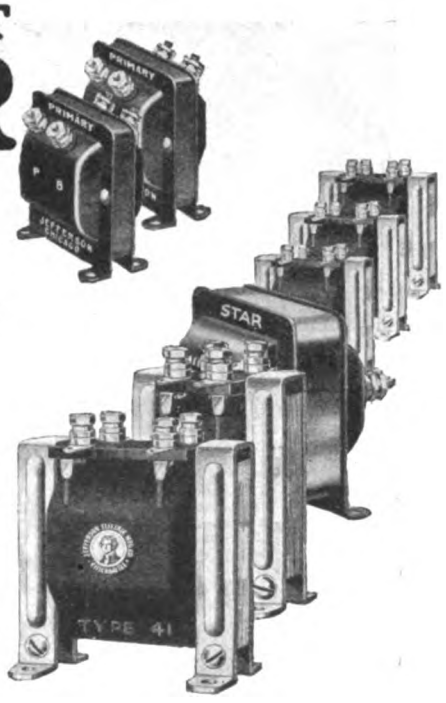
IF YOU WANT A TRANSFORMER

"that makes it clear when you're near"
USE A JEFFERSON
"to bring them in just as clear from afar"
USE A JEFFERSON
"that has just the right characteristics to meet your particular requirement—two radio—six audio frequency"
USE A JEFFERSON
"that is made by a company who have specialized in this field for more than a generation"
USE A JEFFERSON



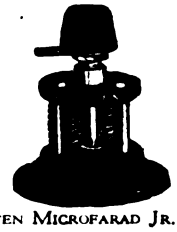
The Name JEFFERSON is Known Wherever Transformers are used.

You are invited to write our Radio Engineering Department for amplification data. Attractive descriptive literature is also available. This service is gratis.

JEFFERSON ELECTRIC MFG. CO.
427 S. GREEN ST., ∴ ∴ CHICAGO

Two Little Chelten Products But They Both Work Wonders

and cost so little



CHELTEN MIDGET VERNIER — CHELTEN MICROFARAD JR.

THE CHELTEN MIDGET VERNIER can be used as a Vernier with any Variable Condenser. It has 13 plates which give unusually fine gradation of capacity. You'll find it recommended by many of the Radio Experts. It costs so little—only $1.50 and it does so much. Adds many miles to most any set. As for the MICROFARAD JR., it too is a tiny instrument but designed as a Neutralizing Capacity Condenser of low capacity, for the New Circuits. Instantly adjustable without body capacity. No shifting of adjustments until you reset it. Costs but $1.75. Just the thing for the Neutrodyne Circuit.

Let us tell you about the new Chelten RADIOSCOPE Condenser and the Chelten SPECIAL Condenser for high oscillating Radio Frequency work.

SEND FOR CHELTON RADIO CATALOGUE

THE CHELTEN ELECTRIC COMPANY

4861 STENTON AVENUE PHILADELPHIA PENNSYLVANIA

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A Set for Every "Hook-Up"

Easy to apply—Permanent—Neat—Economical

Set No. 1—Complete for detector, tuner and 3 stages of R.F. or A.F. amplification. 40 words and signs. **50c**

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Each package complete with special cement and directions

At your Dealers or sent Postpaid on receipt of stamps

Bruno Radio Corp. 296 Water St. NEW YORK

Below is a full size reproduction of a "Bruno" Engraving

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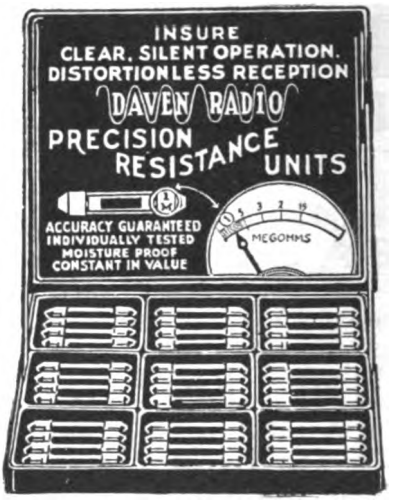

PRECISION RESISTANCE UNITS

Amateurs and Radio Engineers who have experimented in the building of Radio Receiving Sets have found that the DAVEN PRECISION RESISTORS are unexcelled. They positively insure quietness and pure tone reception—for satisfaction sake try one and note the difference in the purity of the tone reception in your Radio Outfit.

If your Dealer cannot supply you, write

THE DAVEN RADIO COMPANY

Radio Resistor Specialists

9-11 Campbell Street :: Newark, N. J.

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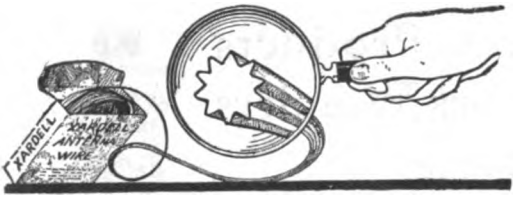

ANTENNA WIRE

$2.00

PER HUNDRED FEET

Designed for long distance reception and is different and better than the usual make-shifts, being hard drawn from the finest copper, having a corrugated surface with ten collecting points on the circumference. This gives a greater collective surface to the high frequency radio currents. The result is extreme sensitiveness and increase in range and clearness of any set from the simplest Crystal to the finest multiple tube receiver.

Use this antenna wire and enjoy the full possibilities of your set.

Sold in coils 100 feet, 200 feet and 500 feet. Order direct or from your nearest dealer.

Dept. R

Xardell Corp.

UTICA, NEW YORK

PREMIER

"Microstat"

TRADE MARK

SUPER-VERNIER RHEOSTAT

Gets 'em All—and Clearly

"MICROSTAT" is in a class by itself as a precision instrument for the perfect control of the filament current in detector tubes, and everyone knows that you must control this current to the finest degree if you are going to get the ultimate from any set—"MICROSTAT" does all this. Built on an entirely new principle. Two windings in parallel—one 6 ohm—other 40 ohm. Absolutely noiseless—infinite control—handles any tube. Cap. 3 Amp. Bakelite moulded—silver etched dial. Do not install a Rheostat until you know all about the "MICROSTAT." Send for our Free Bulletin No. 92, explains it in detail. Ask your dealer.

$3.00 and worth it

Premier Electric Company

3807 Ravenwood Ave. CHICAGO

Please refer to POPULAR RADIO *when answering advertisements.*

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THE CALLOPHONE
LOUD SPEAKER

A Handsome Addition to Your Home

that will faithfully reproduce the broadcasting, program. Its soft, mellow tones of pleasing volume will bring the artist *home* to you as no other loud speaker can do.

Each Callophone is made with exacting care—tested under actual operating conditions—and *sealed* before shipment.

The Callophone is absolutely GUARANTEED—and will be kept in repair and adjustment free of charge—*as long as the seal remains intact.*

A dial adjustment of the diaphragm regulates the volume and enables you to adjust it to your particular type of receiver. No extra batteries are required.

The Callophone is $35.00. And here is the test we want you to make: compare it with any loud speaker you have ever heard—*if you are not satisfied* with its superiority—return it and the full purchase will be refunded to you.

"Made by the makers of Callophone Commercial Loud Talking Apparatus—recognized for years as the best."

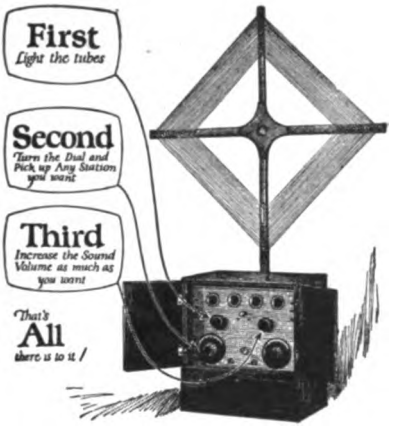
If unable to secure Callophone from your dealer send direct to

THE CALLOPHONE COMPANY OF NEW YORK, Inc.
216-222 Mercer Street
New York, N. Y.

See How Easy It Is

to Get the Radio Broadcast from all over the Continent

If you Have a DE FOREST RADIOPHONE!


First
Light the tubes
Second
Turn the Dial and Pick up Any Station you want
Third
Increase the Sound Volume as much as you want
That's All there is to it!

NO OUTDOOR ANTENNA—The Loop as shown is all you need, though the De Forest Reflex can be used with outdoor aerial if desired.

NO OUTSIDE BATTERIES—All Dry Cells go inside the box, although the set can be used with the storage batteries if desired.

NO GROUND—No outside wires or connections of any sort. The set gets cross-continent broadcast just as you see it with great clearness.

The world-famous De Forest Reflex Radiophone, type D-10, is a 4-tube set with a range on indoor loop of 3,000 miles (record range 5,000 miles). It has a reputation for the clearest reception of broadcast in existence. Uses either head phones or loud speaker. The simplest long-distance set made; low in first cost; economical to operate. Price for set and loop, $150.00, plus 6% for territories west of the Rockies.

FREE RADIO CATALOGS Send us your name and address and we will send you the new De Forest Catalog with full details and prices on sets, audions, and parts.

DE FOREST RADIO TEL. & TEL. CO.
Dept. P. R. 7 Jersey City, N. J.

De Forest Radiophones

"Made by the Man who Invented Broadcasting"

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TYPE AI
$25.00
21" Fibre Horn

The TRINITY LOUD SPEAKER

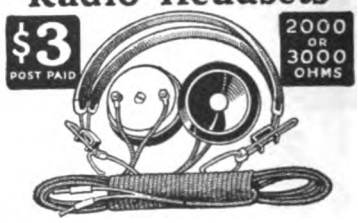
The Trinity Loud Speaker is an instrument that combines the best qualities of a phonograph reproducer in combination with electro-magnetic principles best fitted for radio amplification.

Perfect reproduction of all music and speech without distortion. No storage batteries required. The instrument is of a heavy duty type and is guaranteed fully by the manufacturers.

For sale by good dealers
Literature upon request

TRINITY RADIO CORPORATION
446½ Tremont Street, Boston, Mass.

EDSON
Tone Tested
Radio Headsets



THE lowest-priced first quality headset on the market today. Compare with headsets costing twice our price. Return ours if not satisfied. Our written guarantee protects you. Send $3.00 by registered mail or money order. Buy direct of us and save the difference. We ship, postage prepaid, same day order is received. Ask for our

Free Catalog of Radio Parts

EDSON RADIO SALES CO.
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YOU DON'T NEED TUBES

To hear concerts from distant Cities.

YOUR CRYSTAL SET

will bring them in if you follow my instructions. You may already have all the parts you need and merely have it HOOKED UP WRONG.

People using my plans hear programs clearly from stations

400 TO 1000 MILES AWAY

No TUBES, BATTERIES, AMPLIFYING APPARATUS or Special Crystal required. My COPYRIGHTED instructions selling for $1.00 are written so anyone can understand. They show you exactly how to fix the set you have or make one like mine.

Satisfaction Guaranteed or money refunded.

Send self-addressed envelope for picture of my set and further particulars. Write me today.

LEON LAMBERT
540 So. Volutsia Street, Wichita, Kansas

Pity the Bug Who Has None!

THE fellow who tinkers and fools around all kinds of adjustments in order to eliminate back alley discord will appreciate this tip regarding Reliable condensers for all tuned radio circuits. You get smooth sounding messages and concerts without difficulty and numerous other advantages with this little device.

The Reliable Parts Mfg. Co.
7306 Madison Ave. Cleveland, O.

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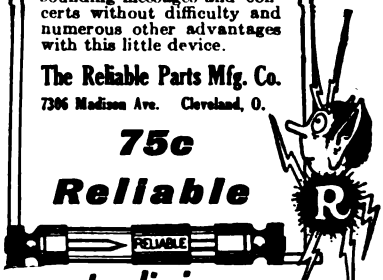
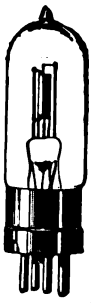
Reliable



neutralizing condensers



WE REPAIR
The Following
RADIO TUBES

WD-11	$3.50	DV-6	$3.00
WD-12	3.50	UV-199	3.50
UV-200	2.75	C-299	3.50
UV-201	3.00	UV-201A	3.50
C-300	2.75	C-301A	3.50
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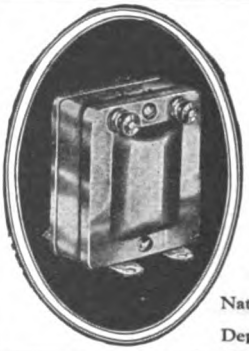
Mail orders solicited and promptly attended to.

Dealers and Agents Write for Special Discount.

H. & H. RADIO COMPANY
Clinton Hill Sta. P. O. Box 22-E. Newark, N. J.



National Audio Frequency Transformers

The New 6 to 1 Ratio National Transformer is for use on the first stage of amplification. Its greater ratio means increased volume, but the tone qualities that characterize the 3½ to 1 ratio have been fully retained. Price of 6 to 1 ratio $4.50 postpaid; of the 3½ to 1 ratio, $4.00 postpaid. *Dealers: Write for interesting sales proposition.*

National Transformer Mfg. Co.
154 Whiting Street
Dept. 311 Chicago, Ill.

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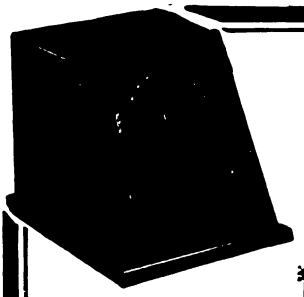


PAT. APP. FOR

We are putting forth every effort to make the Control-o-meter easy to get through local dealers, but should you be unable to secure a Control-o-meter, we will ship you one postpaid on receipt of price.

$12.50

Separate Overlapping DISTANT Stations *with a*

CONTROL-O-METER

In every section of the country, owners of every type of set are finding that the utility of the Control-o-meter is not confined to eliminating interference from local broadcasting stations. They are discovering the ease with which two *distant* programs on overlapping wave lengths can be separated and either one brought in. This feature of the Control-o-meter means that you can hear stations which before were lost to you in a junble of words and music.

THE CHART MAKES IT EASY

Every Control-o-meter is individually calibrated in our laboratory and a chart showing the "vanishing point" for various wave lengths is supplied with each instrument.

The Control-o-meter works equally well with any type of set regardless of location or antenna.

MALONE-LEMMON PRODUCTS

Made by STEPHENSON LABORATORIES

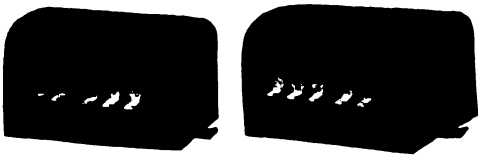
342 MADISON AVENUE

NEW YORK CITY

Como Duplex Transformers

(Push-pull System)

The best and biggest selling transformer in the field. Merit alone has done it! The *"Como Duplex" was first* and we are being copied continually by those who lack the skill and knowledge to create. Imitation is the sincerest form of flattery and lots of manufacturers are flattering us. Mr. Laurence M. Cockaday, famous designer of radio circuits, having the world's best transformers to choose from has specified "Como Duplex" in his new 4 circuit tuner. This should be a sufficient guarantee for anyone.



Price $12.50 per matched pair

"Como Duplex" system of amplification gives a maximum volume without distortion and tube noises.

May be added to your present amplifier giving you power amplification on the weak signals that more of the ordinary amplification would kill.

A copy of "How to Make a Power Amplifier" is yours for the asking

COMO APPARATUS COMPANY, 446 Tremont St., Boston, Mass.

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Charge Your Radio or Auto Battery at Home Overnight for a Nickel with the

GOLD SEAL HOMCHARGER

—the world's best as well as its most popular rectifier. Simple, dependable, practically silent and absolutely safe. Beautifully finished in mahogany and gold—an ornament for the finest living room.

Why Pay More—Or Get Less?

Why buy a 2 or 3-ampere rectifier without ammeter requiring from 40 to 50 hours to charge your battery and costing twice as much to operate when, for the same price, you can secure the genuine 5-ampere GOLD SEAL HOMCHARGER which does a better job in one-third the time and at half the cost? Fitted with high grade ammeter (eliminating guesswork) charging cable and battery clips—no extras to buy. For sale by all good dealers, $18.50. ($25.00 in Canada.)

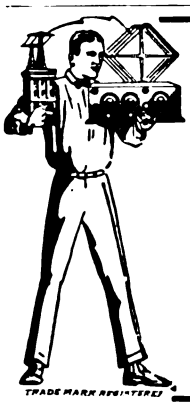
Insist on the Gold Seal

It's your guarantee against substitution and appears on nameplate and package. No other charger is just as good.

Radio Fans, Attention!

FREE Ask your dealer or send direct for free HOMCHARGER list of broadcasting stations and GOLD SEAL bulletin.

The Automatic Electrical Devices Company
132 West Third St., Cincinnati, Ohio
Largest Manufacturers of Vibrating Rectifiers in the World



TRADE MARK REGISTERED

LAVITE RESISTANCES

1,000 OHMS	$1.00 Each
12,000 "	
48,000 "	
50,000 "	
80,000 "	
100,000 "	

Money Orders and Checks Only
NO STAMPS

HAROLD HERBERT Inc.
160 W. 46th St., N. Y. C.

Regal

"Pays For Itself In Longer Service"

Broadcast Tested, High Quality Audio Transformer

For clearness of tone, amplification of voice and music from nearby and distant broadcasting stations, is unequaled by any Transformer on the market.
3½ to 1 Ratio... $4.25
5 to 1 Ratio... 4.50

Fifteen Taps—But Only One Drill Hole Required!

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of holes. No more chipped panels. Complete with hard rubber Knob and Dial.
Type No. 162.... $1.50

Perfect Contact Vernier Rheostat

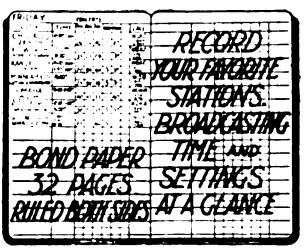
For fine filament control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market. Complete with Knob
6-Ohms..... $1.25
30-Ohms..... 1.25

At all good dealers—otherwise write direct for complete descriptive folder No. 24, sending dealer's name.

AMERICAN SPECIALTY CO.
Bridgeport, Connecticut, U.S.A.

GET YOUR STATION

WHEN YOU WANT IT WITHOUT FISHING



Stop wasting time on silent stations. Send a quarter for this handy radio reference and list all stations you hear.

CONTAINS A LIST OF ALL BROADCASTING STATIONS

SECURITY SALES CO.
3051 MARCUS AVE. ST. LOUIS, MO.

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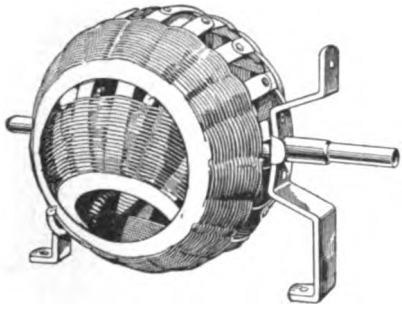
AMRAD
BASKETBALL VARIOMETER



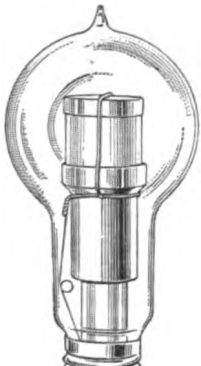
Improved Type 3650 Price only $3.75

Vario-Coupler Type 3800 Price only $3.85

THIS WELL-KNOWN TECHNICAL EDITOR SAYS—

"Variometer No. 4 (the AMRAD BASKET-BALL) is probably the most efficient instrument of the lot on the market. One glance at its construction will show that the possibility of electrical losses has been practically eliminated . . . . . THIS VARIOMETER HAS BEEN SELECTED BY THE BUREAU OF STANDARDS FOR MOST OF THEIR EXPERIMENTS AND THIS ITSELF IS A VERY CONVINCING PROOF OF ITS ELECTRICAL EFFICIENCY."

Write for Descriptive Bulletin V



Improved AMRAD "S" Tube No. 4000 Price $10.00

"S" Tube Rectifier

Operates CW Transmitters, utilizing either 5 or 50 watt power tubes. May be used to charge Storage "B" Batteries. Fits standard base. A 100% rectifier. No Filament to burn out.

Write for new Bulletin J-2 describing the "S" Tube and containing diagram showing methods of connecting tubes for obtaining various voltage and current.

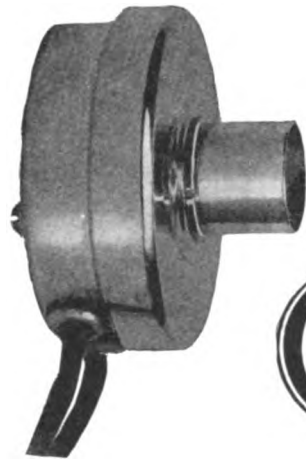
AMERICAN RADIO AND RESEARCH CORPORATION
DEPARTMENT P
MEDFORD HILLSIDE, MASS.
AMRAD Dealers in Principal Cities and Towns

Listen to the Difference!

and only

$6.50

with 6 ft. of cord



CIC

Phonograph Attachment

When you use your phonograph for a loud speaker you get all the advantages of a perfectly designed horn more than three feet long. When you use the C. I. C. Phonograph attachment with its adjustable air gap and mica diaphragm you get a volume and a tonal beauty that will give you a new conception of Radio. Adaptable to all phonographs as well as to all makes of amplifying horns.

Send for Leaflet

CONNECTICUT INSTRUMENT CO.
STAMFORD, CONN.

Coast Distributor
Globe Commercial Co., San Francisco, Los Angeles, Seattle.

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The long-life tube!

(½ size)

Since their inception, radio vacuum tubes have been fragile. To knock or drop one incurred the expense of a new tube. But now there are

MYERS TUBES

Practically Unbreakable

—so protected by their unique design that they have been dropped on the floor without injury.

But their sturdiness is only one feature. They are the most perfect detectors and amplifiers obtainable. Smaller capacity and no bunched leads mean less interference—more clarity and greater amplification. Actual tests, all over the world, have proved their supremacy.

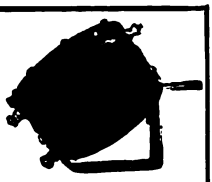
$5

EACH Complete with clips ready to mount on your set; no sockets or extra equipment required.

Two types—**Dry Battery** and **Universal** (for storage battery). At your dealer's otherwise send price and be supplied postpaid. Write for free circuit diagrams.

E. B. Myers Co. Ltd.
Radio Vacuum Tubes
240 Craig St. W., Montreal

Better Tuning



with

Bremer-Tully Vernier Tuner

says:—N. T. Bradford, Terra Bella, Cal.

"I assembled your No. 2 with two stage amplifier at an expenditure of two hours time including the amplifier. *Since that time my Neutrodyne has been laid away,* and all our radio receiving has been by way of No. 2. The tones are the best of any set I ever *operated.*"

Better Tuning
Tells you why—shows you how. Sent on receipt of 10c. Free with each tuner.

BREMER-TULLY MFG. CO.
534 S. Canal St. - Chicago, Ill.

BLUE SEAL
Howard
GUARANTEED PRODUCTS
Radio Co. Inc. Chicago, U.S.A.

HOWARD

No. 1001
6½ Ohm Rheostat..... $1.10
25 Ohm Rheostat..... 1.10
40 Ohm Rheostat..... 1.10
Patd. 870,042

HOWARD

No. 1003
200 Ohm Potentiometer. $1.50
400 Ohm Potentiometer .2.00
Patd. 870,042

Ask the man behind the counter to show you the **Howard** line of quality Radio Merchandise. Every piece is sold with the **guarantee** of **satisfactory** performance.

Jobbers write for discounts.

Send two cents for folder.

HOWARD

No. 1002
6¾ Ohm Micrometer Rheostat... $1.50
25 Ohm Micrometer Rheostat..... 1.50
40 Ohm Micrometer Rheostat..... 1.50
Patd. July 10, 1923

HOWARD

No. 1004
Multi Terminal Receiver Plug, instantaneous connection for as many as six pairs of standard receiver tips..... $2.00
Patd. Aug. 28, 1923

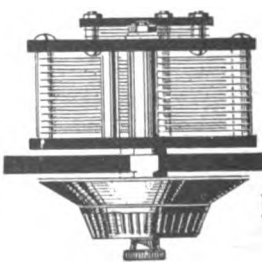
HOWARD RADIO CO., Inc.
4248 North Western Ave., Chicago, U. S. A.

RATHBUN
SINGLE-HOLE MOUNTING
SUPERIOR CONDENSERS

Special—13 Plate

NEUTRODYNE
CONDENSERS

Designed specifically for Hazeltine Neutrodyne receivers. The absolutely precise tuning required in the circuit is assured by this superbly made condenser. Capacity effects eliminated by single hole mounting feature. No stray magnetic fields. Use the Rathbun Condensers when you build your Neutrodyne Receiver to be sure of easy tuning.



Capacity
.0003 MFD
LIST
$3.00

Write TODAY for the name of the nearest **Rathbun** dealer and for illustrated literature.

RATHBUN MFG. CO.
Jamestown, N. Y.

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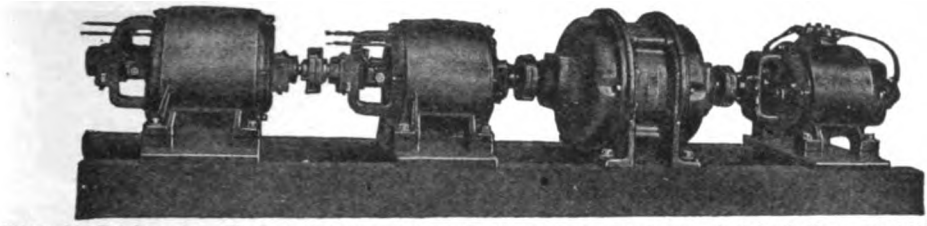
"ESCO"
TRADE MARK

Generators — Motors — Dynamotors — Motor-Generators, Stand Supreme in Wireless Field



This special 4-Unit Set made for Wis. Dept. of Markets—the largest Broadcasting Station in existence. A 10 H. P. Motor—two 1,000 V., 2,000 W. Generators to operate in series, producing 2,000 V. and 4,000 W. and one 12 V. 2,000 W. Filament Current Generator.

BATTERY CHARGER
Many Sizes—with or without Panels

Send for Bulletin 237A listing over 200 combinations. We design and develop Special Apparatus for Special Purposes.

Sold by Principal Dealers Everywhere

ELECTRIC SPECIALTY COMPANY

230 South Street
Stamford, Conn., U.S.A.

Pioneers in developing High Voltage Apparatus

DYNAMOTOR
Sizes to fit all requirements

A Radio Part with a Double Purpose—

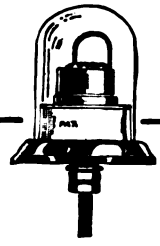
GREWOL VARI-GRID

Learn the secret of Grid Control thru the *condenser*. Varying the capacity of your tube is what gives results.

The Vari-Grid is a vernier .0005 condenser, 1¾" diameter, adapted for *all* condenser circuits. Lowest losses. Finest adjustment. Best results wherever used. Guaranteed by manufacturer.

Write for "Grid-Control," by Lefax editor. It's Free.

If your dealer cannot upply you, order direct..... **$2.25**



GREWOL Fixed-Reflex DETECTOR

Guaranteed not to burn out.

At your dealer's or direct - - - - - - - **$2**

RANDEL WIRELESS COMPANY
4 Central Ave. **Newark, N. J.**

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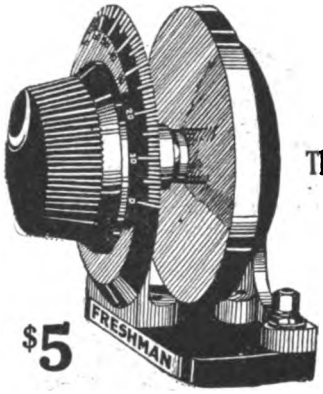
"FRESHMAN SELECTIVE"

MERCURY VARIABLE CONDENSER



FOR TRANSMISSION OR RECEPTION

$5

It is the only variable condenser the plates of which vary in area—***an engineering feat never accomplished before***—making it most efficient for fine adjustment and selective tuning.

The "Freshman Selective" is attractively compact, quiet in operation and will withstand 5,000 volts without leakage or danger of short circuiting.

.0003 m. f. (equivalent to 17 plate)
.0005 m. f. (equivalent to 23 plate)
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Each $5

At your dealer's, otherwise send purchase price and you will be supplied postpaid

Ask your dealer or write for our free diagrams of Neutrodyne, Tri-Flex, Kaufman and other good circuits.

Chas. Freshman Co. Inc.
Radio Condenser Products
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Guaranteed Head-Sets

"RED-HEADS" are *guaranteed* radio phones. You run no risk when you buy them. Money back if, after 7 days' trial, you're not satisfied that they're the *best* receivers on the market at the price. Why not act *right now* and get a pair? It'll mean getting the *maximum* from broadcasting from the day you put them into use.

RED-HEAD RADIO RECEIVERS

NOW READY

The new 1924 Model F **$6.50** Per Pair Complete

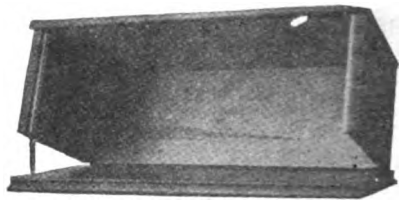
The new "Red-Head" Jr. **$5.00** Per Pair Complete

"Red-Heads" sent prepaid on receipt of price if you are unable to get them at your dealer's.

The NEWMAN-STERN COMPANY
Dept. PR Newman-Stern Bldg. Cleveland

Here Is The CABINET YOU Have Been Looking For

Highest Quality **CORBETT'S CABINETS** Latest Designs



This cabinet is hinged to base with loose pin hinges permitting entire clearance or removal for convenience. Top and base shaped, later being raised to allow clearance for wiring and screws underneath. Panel to be fastened to base, and no sub-base required.

Panel	Depth	Price	Panel	Depth	Price	Panel	Depth	Price
6x10 ½"	7"	$2.60	7x14"	8"	$3.50	7x24"	8"	$4.90
6x21	7	3.85	7x18	8	3.80	7x26	8	5.10
7x10	8	3.15	7x21	8	4.35	12x14	10	4.35
7x12	8	3.30						

All sizes also furnished in old style hinged top and grooved front, no screws required. Price 10% off above list. Genuine Oak, dark finish, or hand rubbed mahogany finished hardwood. Odd sizes to order. Discounts to dealers —our cabinets will sell over the counter. Guaranteed to please or money promptly refunded. Catalog free.

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Flexible cloth binding. Gold stamping. 160 pages. Printed on Bond Paper. Contains introductory article "How to Receive Radio Broadcast," by Lloyd C. Greene, Radio editor Boston *Globe*. Many Radio Hints and Tips. Complete list of Broadcasting Stations and double page map of United States.

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RADIO TUBE EXCHANGE

We Repair All Standard Makes of Tubes Including

W. D. 11 or W. D. 12	$3.50
U. V. 200 or C. 300	$2.75
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New 1½ Volt Tubes	$4.00

All tubes guaranteed to do the work.

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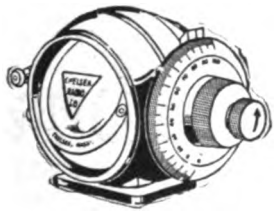
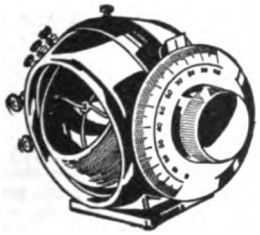
SHARPER TUNING
AND
MORE VOLUME
with CHELSEA parts

Insist on getting a Chelsea
VARIOMETER with VERNIER
An exclusive feature
Genuine bakelite insulation
Pigtail connection to rotor



 # 80 with dial and vernier $8.00

The only variocoupler with binding post connections. Another exclusive Chelsea feature
Genuine bakelite insulation
Pigtail connection to rotor
Absolutely guaranteed



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Chelsea offers a complete line of parts and sets
At your dealers or write direct

CHELSEA RADIO COMPANY
183 SPRUCE STREET
Chelsea, Mass.

Police Sergeant Charles E. Pearce who erected and operated the first successful police radio station in the world — a former student of the Radio Institute of America.

Radio—your chance

From no knowledge of radio—to licensed operator. From operator up the opportunity ladder to the big job at the top. And a life of fascinating interest, well paid. That is every man's chance now that the famous course of America's oldest radio school is offered for *home study.*

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The demand for trained men is great—and growing. Now, no matter where you live you can *study at home* under the best instruction. Write today! Get your start—and grow with radio.

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Great popular demand by the advanced student, experienced amateur, and wireless operator has led to the opening of an ADVANCED HOME STUDY RADIO COURSE, specializing in C. W., I. C. W., telephone and radio measurements. Investigate!

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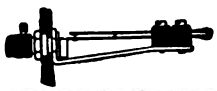

$1

Compact—durable—mounts like jack; heavy phosphor-bronze springs—silver contacts. Westinghouse "Micarta" insulation.
Furnished complete with "On and Off" Name Plate, Knob and Pointer. Made in four styles.
Write for catalog complete line Carter quality Radio Products, including special hook-up for Jack-Switches.

Carter Radio Co.
1807 REPUBLIC BUILDING
CHICAGO

NA-ALD
De Luxe Dials

The artistic qualities of Na-ald De Luxe dials distinguish these dials as truly beautiful. They add to the appearance of any set in which they are used.
Na-ald Dials have a high gloss finish. They are moulded of genuine Bakelite and have patented construction. Dials are matched and made in 2", 3", and 3¼" sizes.

Alden Manufacturing Company
Largest makers of Radio sockets and dials in the world
Dept. C 52 Willow St.
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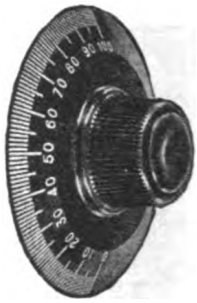

No. 3003—4
3 Inch
35c, 3 for $1.00

RADIO "B" BATTERIES
AT FACTORY PRICES

Greatest radio "B" battery on market. Full number voltage taps; QUALITY GUARANTEED; LOWEST PRICES; brings in concerts LOUDER AND STRONGER; will work on any tube or loud speaker. Order by number TO-DAY with check, money order or pay postman C. O. D.

No. 122B 22½ volt variable, regularly $2.25... **$1.52**
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No. 145A 45 volt, 8 taps, regularly 5.50... **3.25**

AYRES BATTERY CORPORATION, Cincinnati, Ohio

CATALOG
E18-100 PAGES FREE

LATEST REFLEX AND NEUTRODYNE CIRCUIT
EVERYTHING IN RADIO

One of the largest complete stocks in the world. 40 diagrams of latest Hookups.

DEALERS ALL OVER THE U.S.

Making big profits handling our supplies. 24-hour service. Goods shipped same day order received.

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SHELTONE LOUD SPEAKER
$3

Made by Du Pont expressly for us. WORKS with any Phones.
Beautiful, transparent, exceptional value. Satisfaction guaranteed.
THE SHELTONE CO.
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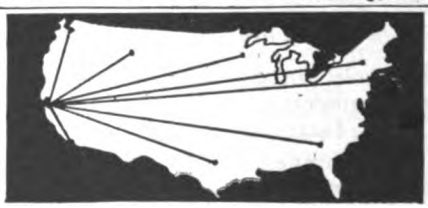

ON ONE TUBE

Broadcasting from Atlantic Coast, Canada, Mexico, Cuba & Hawaii heard in Calif. by users of the CROSS COUNTRY CIRCUIT. Range due to simplicity. One tuning control. ANY NOVICE can build easily and cheaply. Dry cell tubes used. No soldering. Complete instructions, Blue print panel layout, Assembly Photo, etc., postpaid 25 cents. Stamps accepted.

VESCO RADIO SHOP, Box PR-117, OAKLAND, CALIF.

Vacuum Tubes
Repaired

WD-11, WD-12, UV-201A, UV-199
and others for

$3.00

Quick service. All tubes repaired by us guaranteed to work as good as new.
Send your dead tubes. We prepay parcel post to you. All you pay is $3.00 to postman.

THOMAS BROWN CO.
511-517 Orange Street Newark, N. J.

IF YOU WANT THE BEST
Use
EBY ENGRAVED
Posts

A complete set at a special price.
And they're EBY posts, so the tops don't come off.
Your dealer will have them and will show you other popular markings.
$1.50 per set

THE H. H. EBY MFG. CO., PHILA., PA.

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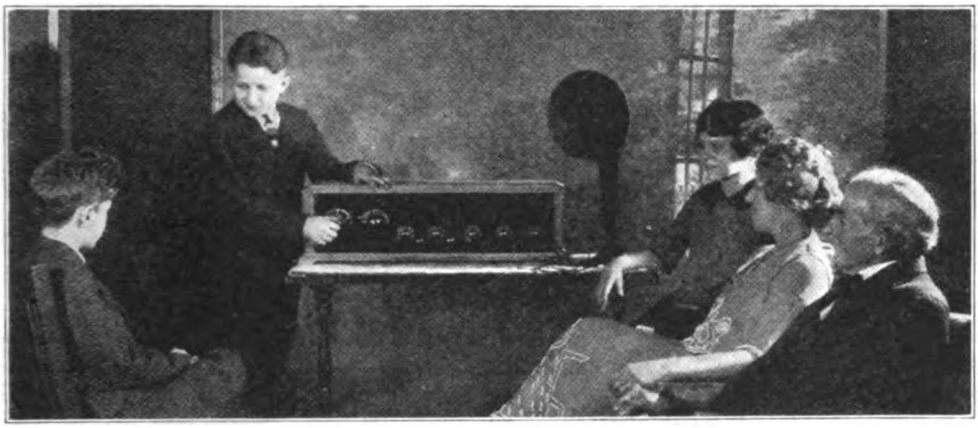


Day-Fan Unit Sets Bring Real Enjoyment to Young and Old

IT makes no difference what program you want to hear, the wonderful new Day-Fan Unit Sets will bring it to your home in tones that are clear, true and without distortion. They eliminate distance, minimize unfavorable conditions, and bring real enjoyment for every age. They are built in either table or panel mountings. So simple, and yet so complete, that even a child can get perfect results.

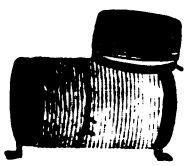
There are four types of units from which twenty-four different sets may be built. Each one is the highest development of its kind, and yet the price is surprisingly low. Your dealer has them in stock or can get them for you. See him before you buy.

THE DAYTON FAN & MOTOR COMPANY, DAYTON, OHIO

Established 1889

SAVE MONEY!

An Amplex Kit costs you 20% to 30% less than the price of all the parts bought separately. Each Kit is complete. No extra parts to buy.



4 CIRCUIT COIL

Built strictly according to Cockaday's specifications. Radion or Bakelite tubing, No. 18 DSC wire. Furnished in Kit, or separate, $5.00.

IMPORTANT

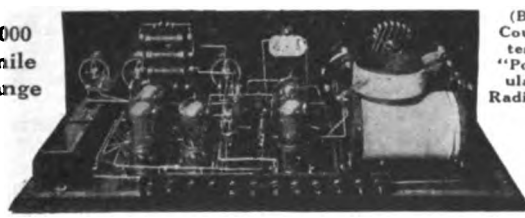
Every part in every Kit is tested, guaranteed, and selected as the most efficient part for that Kit's circuit. Individual parts may be purchased separately at list price.

BUILD YOUR SET

The AMPLEX KIT WAY

The Safe, Simple, Money Saving Way

3000 mile range



(By Courtesy "Popular Radio")

COCKADAY IMPROVED 4-CIRCUIT KIT

Parts	List Price Each
1—Panel 7" x 24" Drilled	$6.00
1—4 Circuit Coil	5.00
2—Amplex 24 Pl. Vari. Cond.	5.00
5—Amplex Sockets	.75
1—6 Ohm Amplex Rheostat	.75
3—20 Ohm Amplex Rheostat	1.00
2—Grid-Densers	1.25
2—Grid Leaks, Var.	.75
1—Amplex Improved Jacks S.C.	.65
2—Amplex Improved Jacks D.C.	1.00
2—Amplex Transformers	5.00
2—Switch Levers, etc	.50

Parts	List Price Each
3—48000 Ohm Res.	$1.25
1—Res. Mounting	1.25
1—.0005 Mica Cond.	.45
1—.00025 Mica Cond.	.45
2—P. P. Transformers, pr.	12.50
1—Potentiometer	1.00
1—Baseboard	1.50
1—Set of plans (blue print)	1.50
12—Binding Posts	.10
Bus bar, etc.	.50

	List Price	Kit Price
1 Tube Cockaday Kit	$26.60	$19.75
3 Tube Cockaday Kit	53.80	42.50
5 Tube Cockaday Kit (Push Pull)	70.85	56.50

AMPLEX INSTRUMENT LABORATORIES

Dept. P :: 57 Dey Street, New York, N. Y.

SAFE AND SIMPLE!

The Amplex Kit takes the "guess" out of Radio.

DRILLED PANEL
COMPLETE INSTRUCTIONS

and blue print for wiring and assembling with each Kit. No special skill or technical knowledge required. Safe and simple to build your set the Amplex Kit-Way.

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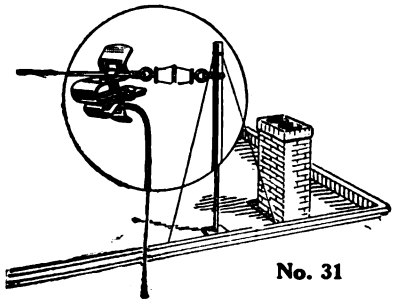

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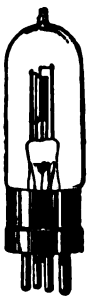

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May, 1922

—Harnessing waves to wire.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How electricity is generated.
—Tones that do and don't broadcast.
—How to make a simple tube Receiving Set.

July, 1922

—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—How to make a variable condenser.

September, 1922

—How to build the Armstrong Circuit Receiver.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922

—How to make a spider-web tuner.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922

—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—The most popular transmitting aerial.
—How to make a novel variocoupler.

December, 1922

—How to select the best coil for your set.
—How to make and use a loading coil.
—A Receiving Set that takes notes.
—How to make a series-antenna condenser.

January, 1923

(Out of stock. A Reprint of Mr. Cockaday's article describing the DX Regenerative Receiver may be had for 22 cents.)

February, 1923 (Out of Stock)

March, 1923 (Out of stock.)

April, 1923

—Regeneration without Radiation.
—How to make a simple single tube Receiving Set.
—Circuit diagram of the Cockaday DX-3 Circuit Tuner, with instructions on how to add three stages of radio frequency.

May, 1923

(Out of stock. A Reprint of Mr. Cockaday's article describing the original 4-Circuit Tuner may be had for 22 cents.)

June, 1923

—How the microphone transmitter works.
—How to build a good single tube receiver.
—How to make a crystal detector stand.

July, 1923

—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

August, 1923

—How to build a Tuned Radio Frequency Receiver.
—Measurement chart for determining the constants for a loop antenna.
—How to calibrate your wave meter.
—Circuit diagram of the original Cockaday 4-Circuit Tuner adapted for use with dry-cell tubes.

September, 1923

—How to get a radio license.
—How weak signals are regenerated.
—How to make a battery charging rectifier.
—How to build the Haynes DX receiver.

October, 1923

—Practical hints for Coil Calculations.
—How to make a Two-stage Audio frequency Amplifier.
—Ten good rules for Broadcast Listeners.
—How to make a simple Honeycomb Receiver.

November, 1923

—The 100 Best Hook-ups (Part 1)
—Receiving without Antennas.
—How to build the New Regenerative Super-heterodyne Receiver (Part 1.)
—How to build a combination Short and Long-wave Receiver.

December, 1923

—How to Select your Radio Parts.
—The 100 Best Hook-Ups (Part 2).
—How to Read a Diagram (Part 1).
—How to Build an efficient Crystal Receiver.
—How to Build the Super-heterodyne Receiver (Part 2).

January, 1924

—How to build the "Improved" Cockaday 4-Circuit Tuner.
—The 100 Best Hook-ups (Part 3.)
—How to Read a Diagram (Part 2.)
—List of U. S. Broadcasting Stations.
—How to build the coupler, oscillator coupler and r. f. transformers for the Super-heterodyne.

February, 1924

—How to add "Push and Pull" amplification to the original 3 tube Cockaday 4-circuit tuner.
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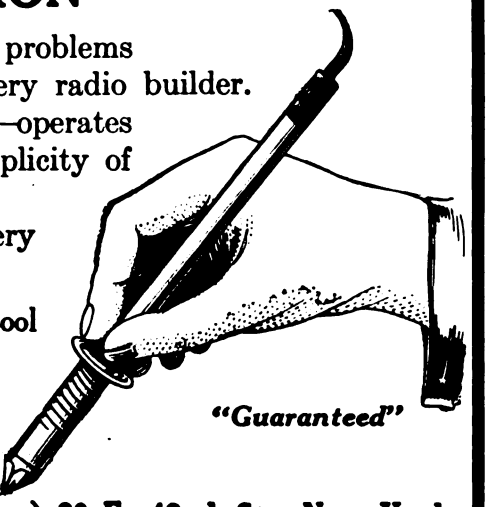

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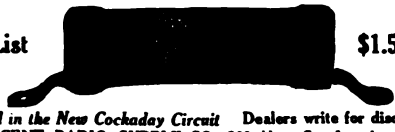
List  $1.50

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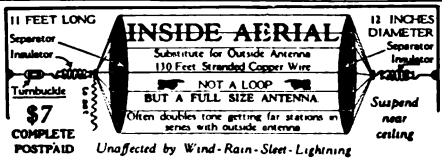

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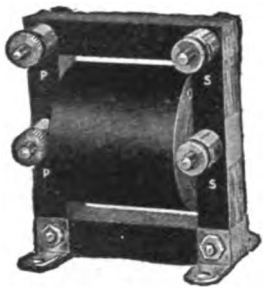

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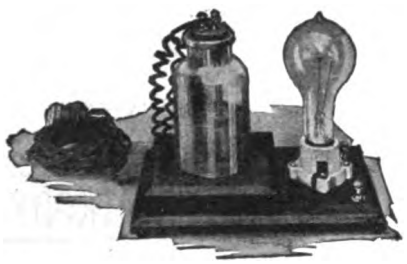

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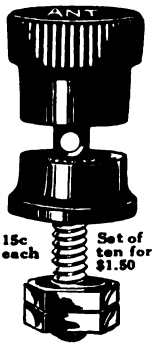

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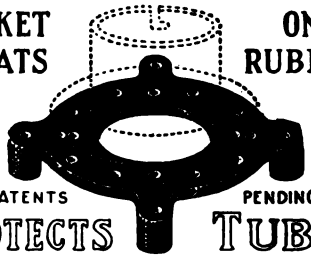

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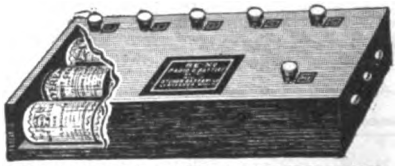

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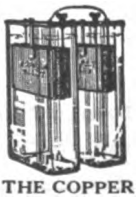

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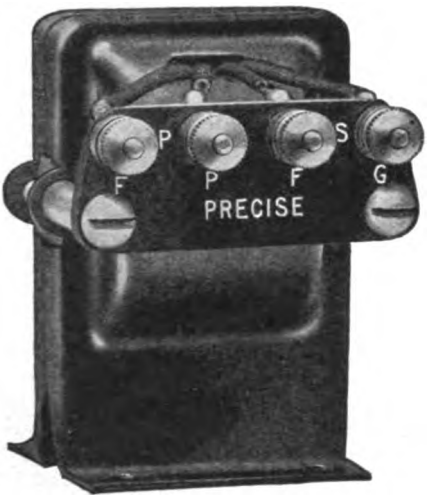
By Merit Alone,



Model 285A—$5.75

Precise Audio Transformers are the choice of those who discriminate.

The 4½ to 1 ratio yields the highest degree of amplification without distortion, and the deeper tones so often lost find their place in the wonderfully realistic recreation of broadcasted music. Recommended for neutrodyne circuits.

Our voltage amplification test chart No. 1094 is convincing of the remarkable performance of this transformer.

Write today for this chart and illustrated circular describing our VERNIER RHEOSTAT and SWITCH LEVER.

Trial Offer

If your dealer cannot furnish these, send us his name or on receipt of price we will forward you any instrument for ten days trial and will refund your money on return if unsatisfactory.

PRECISE MANUFACTURING CORPORATION

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Distributed in Canada by Perkins Electric, Ltd.

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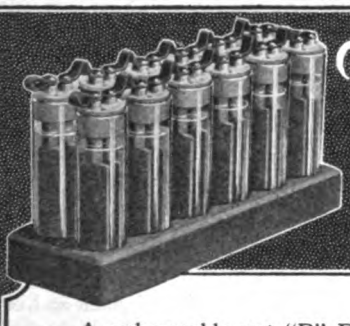

The RāBAT a Rechargeable Wet 'B' Battery at Only $3.96

A rechargeable wet "B" Radio battery built strictly on storage battery principles. Yet it costs only a trifle more than an ordinary dry cell battery.

The Rabat at the low price of $3.96 has 12 cells with a total of 24 volts and ample capacity. It is noiseless, fool-proof, and compactly constructed. Built on a solid rubber base. Small, but neat and efficient. All elements visible. No internal discharge. More economical. Longer life. Higher and more continuous voltage. Easily recharged at home with aid of inexpensive Rabat Rectifier. If your dealer cannot supply you send direct.

South of Tennessee and West of the Mississippi, East of Rockies—$4.25
West of Rockies—$4.40
Rabat Rectifier for Recharging $ .75

THE RADIO RABAT COMPANY
301 RUSSELL BUILDING Playhouse Square CLEVELAND, O.

12 CELLS The RāBAT 24 VOLTS

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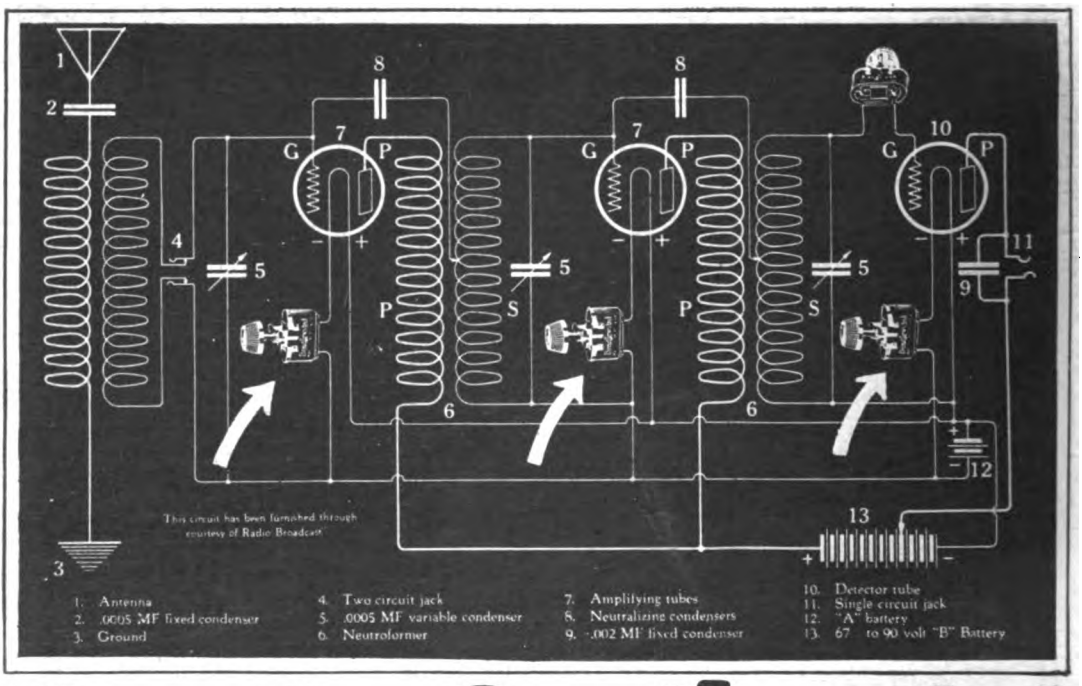
This circuit has been furnished through courtesy of Radio Broadcast
1. Antenna
2. .0005 MF fixed condenser
3. Ground
4. Two circuit jack
5. .0005 MF variable condenser
6. Neutroformer
7. Amplifying tubes
8. Neutralizing condensers
9. .002 MF fixed condenser
10. Detector tube
11. Single circuit jack
12. "A" battery
13. 67 to 90 volt "B" Battery

Use the Bradleystat in the Neutrodyne

THE discriminating radio fan is forever improving his set. At first, the actual accomplishment of radio reception is all that is asked, but in a short time new hookups are tried or new equipment is used to improve reception.

A good hookup is worthless without good equipment and, of all things, perfect filament control is most important. The high efficiency of a good tuner is quickly lost with poor filament control.

The Universal Bradleystat makes any radio set better. Its noiseless, stepless control never fails to surprise and delight the radio fan trying to make long distance records. The recent Radio Broadcast long distance contest gave the Bradleystat first place for superior performance. Replace your present rheostat with Bradleystats and enjoy better radio.

WHEN YOU BUY A RADIO SET, ASK FOR BRADLEYSTATS

Mail This Coupon—TODAY!

Allen-Bradley Co.,
276 Greenfield Ave., Milwaukee

Please send me information about the Universal Bradleystat, the perfect filament control. I want better radio reception.

Name .....

Address .....

.....

In U. S. A.
$1.85
at all dealers

Allen-Bradley Co.
Electric Controlling Apparatus
276 Greenfield Ave. A-B Milwaukee, Wisconsin

In Canada
$2.50
at all dealers

MANUFACTURERS OF GRAPHITE DISC RHEOSTATS FOR OVER 20 YEARS

Please refer to POPULAR RADIO *when answering advertisements.*

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And now, every home can have an Aladdin's Lamp—

These fireside listeners can turn a dial, and find themselves instantly at the very footlights of an Eastern Symphony stage—cheering a Presidential candidate in a far-off city—thrilling with the vast throng at a Varsity game! Even the Genii of the Lamp would have marveled at this great new magic and this wonderful new land of enchantment.

Choose the Right Receiver And You Can Choose Your Program—

C & W Receivers have proved by actual test to be more highly selective than any other instruments in their class. Owners state they get distance without interference from powerful local stations—*enjoy* broadcasting stations 1000 to 2000 miles distant.

The Console Model illustrated, a highly selective 4-tube receiver, is a beautiful furnishing for your home as well as a wonderful means of pleasure and entertainment. Completely self-contained in a handsome Walnut Finish, Early English Period Console, with tubes, batteries and Magnavox loud speaker all in cabinet. Special C & W double circuit; shock absorbing tube mounts, shielded panel, automatic rheostat switch. Finest materials, simple sturdy construction, an efficient, moderate-priced instrument.

$325

Ask Your Dealer to Demonstrate

Cutting & Washington Radio Corporation

Minneapolis :: :: :: Minnesota

Cutting and Washington

STANDARD OF EXCELLENCE IN RADIO SINCE 1914

PRESS OF WILLIAM GREEN, NEW YORK

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Built by the Master Builder

In radio, where precision decides between results and failure, the trade mark of the most famous electrical control engineers in the world furnishes a true basis for confidence. Buy with care and you can build with satisfaction.

CUTLER-HAMMER

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Popular Radio

Edited by KENDALL BANNING

25¢

APRIL
1924

A SIMPLIFIED NEUTRODYNE

How to Build a Non-regenerative Radio-frequency Receiver—

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TELEDYNE

5 Vital Improvements in Radio

Dr. Cutting and Mr. Washington have struck at the very heart of the radio problem in the development of the TELEDYNE —1924's greatest set.

1. **TELEDYNE is super-sensitive, catching and developing the weakest signals.**
2. **Extremely selective—TELEDYNE tunes local stations *out*.**
3. **Greater volume—a real LOUD-speaker set.**
4. **NO radiation—no regeneration howls on the air.**
5. **Easy to pick up new stations—no need for a "log."**

Four tubes do the work of five, saving tubes and batteries. Price, complete with all tubes and batteries, contained in cabinet $190

See the Console Model, complete with Loud-speaker.
Ask a C&W Dealer to demonstrate

The Cutting and Washington Radio Corp., Kasota Bldg., Minneapolis, Minn.

Cutting and Washington

Standard of Excellence in Radio Since 1914

Digitized by Google

Brandes
The name to know in Radio
Table Talker.... $10.00
Navy Type Headset 8.00
Superior Headset.. 6.00
All Brandes products are sold under a money back guarantee by reliable dealers everywhere.
Table Talker 50c. additional west of the Rockies.

© C. Brandes, Inc., 1924

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(Cover design by Frank B. Masters)

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, B.E., *Technical Editor*

For advertising rates address E. R. CROWE & Co.
New York: 9 East 40th St. Chicago: 225 North Michigan Ave.

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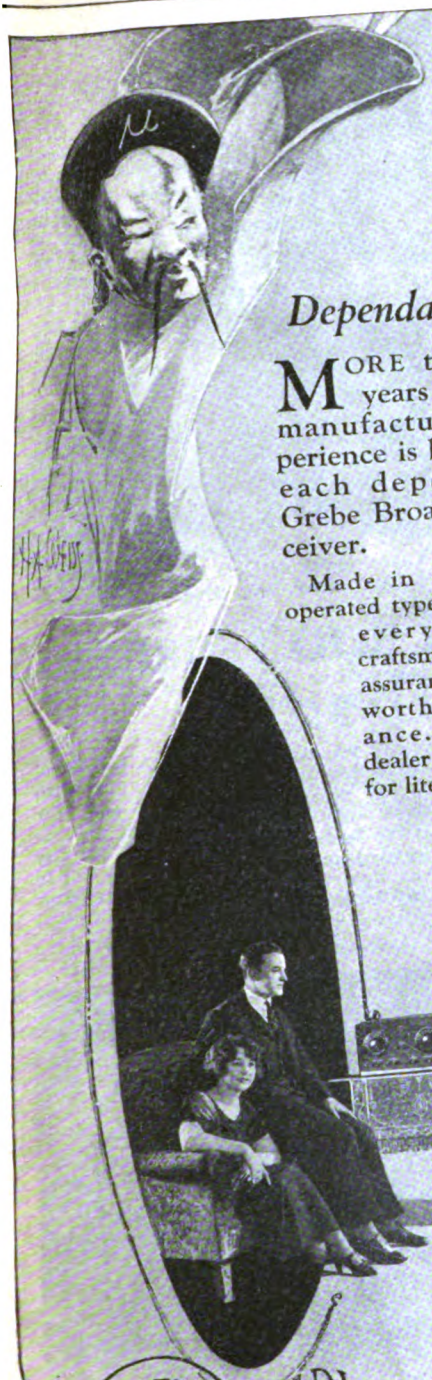

"IT is only when the cold season comes that we know the pine and cypress to be evergreens."
Confucius

In the real test of performance the GREBE Broadcast Receiver establishes its true merit.
Doctor Mu.

Dependability!

MORE than ten years of radio manufacturing experience is built into each dependable Grebe Broadcast Receiver.

Made in two easily operated types, in which every detail of craftsmanship is an assurance of trustworthy performance. Ask your dealer or write us for literature.

Type CR-14—A 3-tube dry cell Regenerative Receiver $110.00
(Accessories extra)

Type CR-12—4 tubes. Combines Regeneration and Tuned R.F. . . $175.00
(Accessories extra)

Licensed Under Armstrong U. S. Pat. No. 1,113,149

GREBE RADIO

A. H. GREBE & COMPANY, INC., Richmond Hill, N. Y.
Western Branch—451 East 3rd St., Los Angeles, Cal.

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PAGES WITH THE EDITOR

ONE of the most interesting of our visitors last month was Svend Skov, a good-looking young Dane who was a member of the crew of the ill-fated *Normania*, sunk in a storm off Virginia on January 17, 1924. In fact, Skov was the radio operator whose efforts brought help in the form of the steamers *Henry R. Mallory* and *Charles E. Harwood*, which rescued the entire crew of twenty-six.

* * *

YOUNG Skov (like all the rest of the crew) lost everything he had on board except such of his clothes as he wore and the overcoat which was given to him by the Danish Consul in New York, where all of the penniless castaways were finally landed. But the lost treasure that he mourned most of all was a complete set of POPULAR RADIO!

* * *

"COULD you let me take back with me to Denmark tomorrow a complete file of the magazine?" asked Radioman Skov. "I have no money at all, but I will pay you when I get home."

Needless to say, our Subscription Manager loaded him up with a complete file (with the exception of four numbers that are out of print) with the compliments of POPULAR RADIO.

* * *

FROM now on POPULAR RADIO will undertake to replace without charge all files of the magazine that may be lost at sea by any ship's operator.

* * *

"LAST summer," reports C. G. Isherwood of Old Shirley, Southampton, England, "I constructed the now famous Cockaday four-circuit tuner from the instructions given by the inventor in your May, 1923 issue, and although I had some difficulty in adapting apparatus of British manufacture to take the place of components specifically advised (unfortunately unobtainable in this country), I was astounded at the remarkable results. On my small antenna, which is only 50 feet long and 20 feet high, I can get WGY and hear every word distinctly as easily as I can get our home stations—not quite so loud, of course!

* * *

"I WAS so enthusiastic over the results that I obtained a dozen copies of the May, 1923 issue and distributed them among my radio friends—seven at least, I know are now regular subscribers. . . . The articles by Sir Oliver Lodge have been of the greatest service to me in my experiments as they contain much data which I have never been able to obtain from any other source.

* * *

"IF the price of POPULAR RADIO were $1.00 a copy, it would be well worth it and I should still be a regular subscriber!"

* * *

SOMETIMES we wonder why the occasional anonymous letter that is furtively mailed to the Editor is invariably scurrilous and why "the truth is not in them." And then we conclude that the bashful author hides his identity because he also knows that the truth is not in them. And then we file the anonymous letter in the scrap basket.

(*Continued on page 6*)

Kadel & Herbert

THEY OWE THEIR LIVES TO AN SOS CALL SENT BY A POPULAR RADIO SUBSCRIBER

Nineteen of the crew of twenty-six of the wrecked Danish ship Normania, *who were rescued by American vessels when Radioman Skov called for help. A complete file of* POPULAR RADIO *went down to join the treasures in Davey Jones' locker.*

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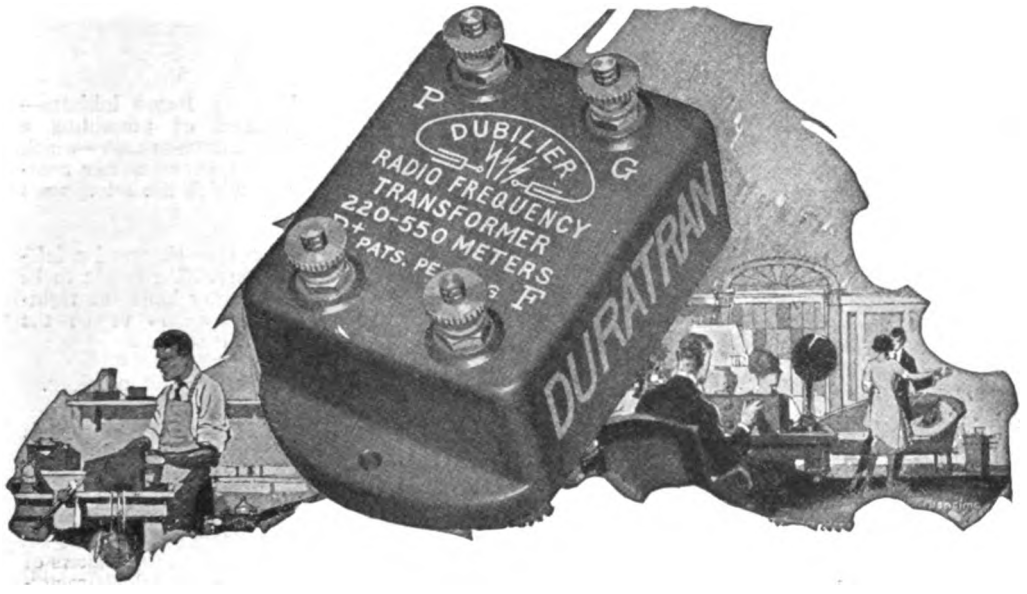


Increase Your Range with the *Dubilier Duratran*

Don't discard your one-tube regenerative set because you can't get the distant stations. The Duratran, the wonderful Dubilier radio-frequency transformer, will bring them in.

Simply add a stage of Duratran radio-frequency amplification to the set. And you will save the ten or fifteen dollars you would spend in buying parts for a new radio-frequency set.

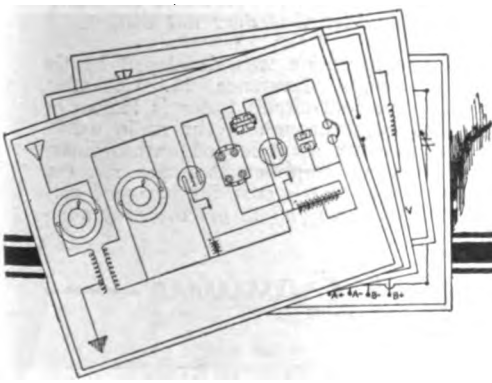
The Duratran will enable you to bring in the distant stations because it amplifies on all broadcasting wave-lengths twenty times. All stations come in with equal clarity because of this unrivalled amplification.

Your dealer sells Dubilier Duratrans. Price $4.00.

Free Blue Prints of Duratran Hook-ups

Ask your dealer for free blueprints of Duratran hook-ups. They show how a Dubilier Duratran will convert your one-tube set into a sensitive radio-frequency receiver.

Dealers: Your jobber will supply you with blueprints of Duratran hook-ups.



Dubilier Condenser and Radio Corporation
40-50 West Fourth, Street, New York

DUBILIER Devices

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(*Continued from page 4*)

Lieutenant-Commander Fitzhugh Green, U.S.N.

ONE of the foremost radio experts of the U. S. Navy, who is writing an important article for POPULAR RADIO.

* * *

WHAT kind of articles do *you* like best in POPULAR RADIO? What kind of articles do you believe can be dispensed with most readily? Which of the departments do you like best—and the least? What additions or omissions can we make that will increase the value of the magazine to *you?*

* * *

THE Editor welcomes both criticism and commendation. Each is helpful. Indeed, some of the most popular features in POPULAR RADIO have grown out of letters of suggestion from our readers—and some of its faults have been eliminated by the same means.

* * *

So many letters from radio operators—amateur and professional—have poured into the editorial sanctum addressed to "The Leader of the Expedition" that will shortly start for a cruise around the world (as announced in the February number) that the Editor has finally persuaded his anonymous friend to come out into the open and reveal his name, his address, his plans and his needs. Here they are:

* * *

HIS name is Barry Buchanan. His address is 16 Gramercy Park, New York. His plans provide for a four-year tour in a 150-foot two-masted schooner with auxiliary engines; he will be accompanied by photographers, scientists and writers—and he needs an experienced operator who will take his pay in adventure and about $10.00 a week, cash, for pocket money. For further particulars, write Barry Buchanan direct.

IN this number POPULAR RADIO initiates—on page 378—the method of presenting a hook-up diagram from RIGHT-TO-LEFT—which is the order in which the experimenter actually works on it and in which the set appears to him, from the rear.

* * *

CONVENTION has heretofore observed a left-to-right diagram—and convention is not to be lightly ignored. On the other hand the right-to-left diagram reading appears to be the logical and more practical form.

Which do the readers prefer?

The Editor will be glad to get opinions.

* * *

HERE is a real idea from a fan who finds the advertising pages of POPULAR RADIO so valuable that he is making a radio encylopedia out of them.

"When I want to buy a new piece of apparatus," he reports, "I am not always able to remember offhand the names of all the makers of that particular thing or the special characteristics of the different makes. So I have begun to put together an encyclopedia of radio apparatus, using the advertising pages of POPULAR RADIO as my material.

* * *

"THE editorial pages I file separately, to be bound. The advertising pages I cut up; I paste each ad in a scrapbook, indexing each one under the pieces of apparatus that it describes—"condensers," "loudspeakers" or whatever it is. Though I have only been doing this for a few months my collection has already furnished me valuable information. Of course, I have to buy *two* copies of your magazine, so that I can keep the ads on both sides of the page. But the results make it well worth while."

—T. E. YAWLE.

* * *

WITH the next issue—May—POPULAR RADIO will be two years old. In celebration of its birthday POPULAR RADIO will treat its readers, not only to a still further increase in its number of pages, but also to another "How to Build" article that will be of special interest and value to every owner of a receiving set, for it will describe how to make an audio-frequency amplifier that *does not distort.*

* * *

THIS new invention was developed by the Technical Editor, Laurence M. Cockaday, whose famous four-circuit tuner is known by millions of fans throughout the radio world. It is not only an amplifier of extraordinary qualities, but an amplifier that the fan can make for himself at a cost for parts of only about $45.00. *Don't fail to get the May number!*

Kendall Banning

Editor, POPULAR RADIO

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The Thompson MAGNAPHONE

Reg. U.S. Pat. Office

Your receiving set can be no better, in delivered results, than the loud-speaker you use with it. The THOMPSON MAGNAPHONE is an instrument that brings out the best that is in your set—because it is specifically designed and built as a radio loud speaker, not merely adapted from other purposes.

All that you've been seeking, and haven't found elsewhere in loud-speakers, is yours with the MAGNAPHONE—the volume, the tone quality, the natural reproduction of the original performance unmarred by mechanical distortion. You'll notice the difference instantly, when you plug in a MAGNAPHONE.

Here are a few features that make the MAGNAPHONE different, and better: cone-shaped special composition diaphragm vibrating equally over its whole area; two-to-one driving armature, reducing the permissible air gap 50%; laminated magnetic pole pieces and generously large magnet. These combine in a structure which forms a loud-speaker giving results so incomparably superior that the MAGNAPHONE is the instant choice of those who demand the best.

Price $35.00—at Good Dealers, Everywhere

Ask your dealer to demonstrate the MAGNAPHONE—compare it with any other loud-speaker, from any standpoint—and you'll admit that Thompson's 14 years' experience in radio manufacture has produced the radio reproducer that satisfies your every requirement.

Manufactured by

R. E. Thompson Manufacturing Co.

Sales Office
150 Nassau St. New York

Factory
Jersey City, N. J.

Manufacturers also of the THOMPSON BALANCED NEUTRODYNE RECEIVER. Licensed under Hazeltine Patents

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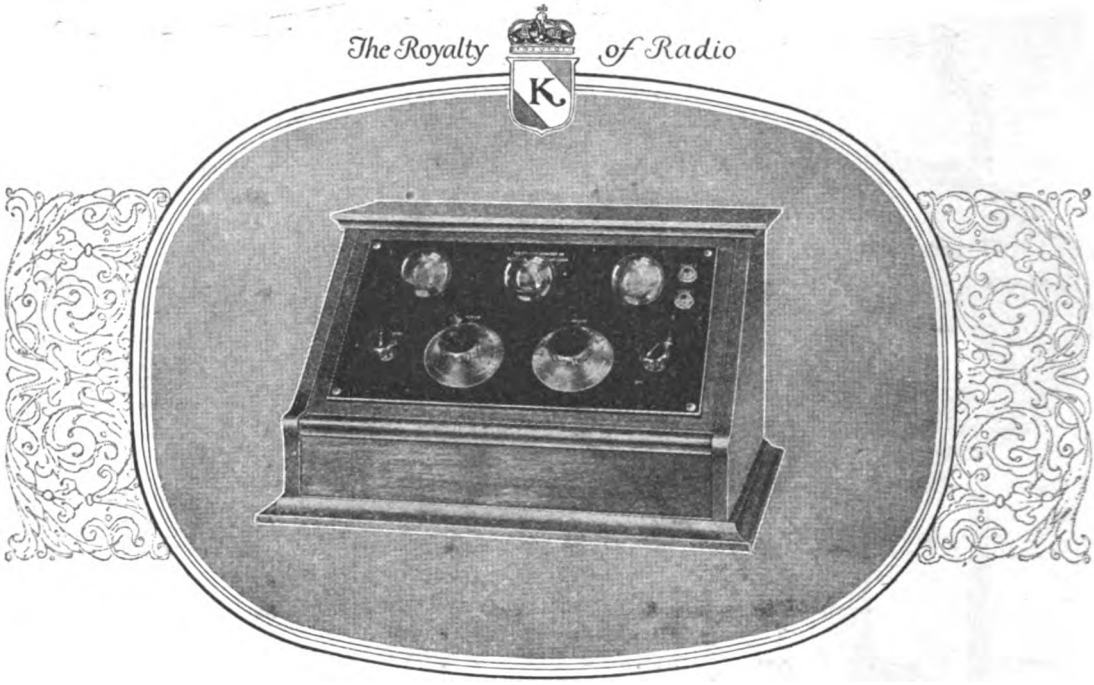
The Royalty of Radio



KENNEDY MODEL V

Like the Artist Standing Before You

So pure, sweet and life-like is the tone of the new Kennedy Radio Receiver, Model V, that it really makes you feel the artist's presence—standing at your fireside—performing for you, in your own home!

And, with this new Kennedy, it is astonishingly simple to bring to your own living room the best broadcast entertainment in the country. You, your wife, mother, son or daughter—anyone—can operate Model V with an ease that brings its own form of fascinating pleasure. Only one dial is used to "tune in" a station—a slight regulation of a second dial controls the volume so you can bring in music or voice soft or pronounced as you wish.

Best of all, when once you have determined the dial setting for any station, that station (if it is broadcasting) will "come in" at its own dial setting—any night, anywhere, regardless of the kind of antenna used.

Think of the possibilities here! Many Kennedy owners make up their own station record—showing the dial setting for each station. How wonderfully simple—merely select the station you wish to hear and set the tuning dial to the number of that station.

Another feature about this new Kennedy is one that your neighbors will appreciate. It does not radiate to any appreciable extent—it does not throw out whining, whistling noises that interfere with listeners living near you.

When you buy your Kennedy Model V, you will add an attractive piece of furniture to your home. The mahogany cabinet is hand-rubbed to a beautiful finish. The polished black Formica panel, in contrast with the mahogany cabinet, creates a pleasing effect. There is no confusing mass of wires dangling from the cabinet and all batteries are completely enclosed.

Model V is really the receiver for you! It is a permanent investment that will bring you years of pleasure. It is sold, completely equipped with all dry battery tubes, dry batteries and Kennedy 3000-ohm phones with plug, for only $125.00 ($127.50 west of Rockies). Other models range from $285.00 to $825.00 (slightly higher west of Rockies) completely equipped, including built-in loud speaker.

$125
fully equipped
($127.50 west of Rockies)

Try this new Model V in your own home—your dealer will gladly arrange this for you. If you cannot locate him, write us direct for fully-illustrated literature covering this and other popular Kennedy models.

All Kennedy Radio Receivers are regenerative. Licensed under Armstrong U. S. Patent No. 1,113,149.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS

KENNEDY

The Royalty of Radio

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International

"Radio Will Make Our Next President"

So *state the politicians, who are beginning to realize the enormous audiences that can now be reached through the ether. This picture shows William J. Bryan before a microphone, firing one of the first of the oratorical guns of the campaign.*

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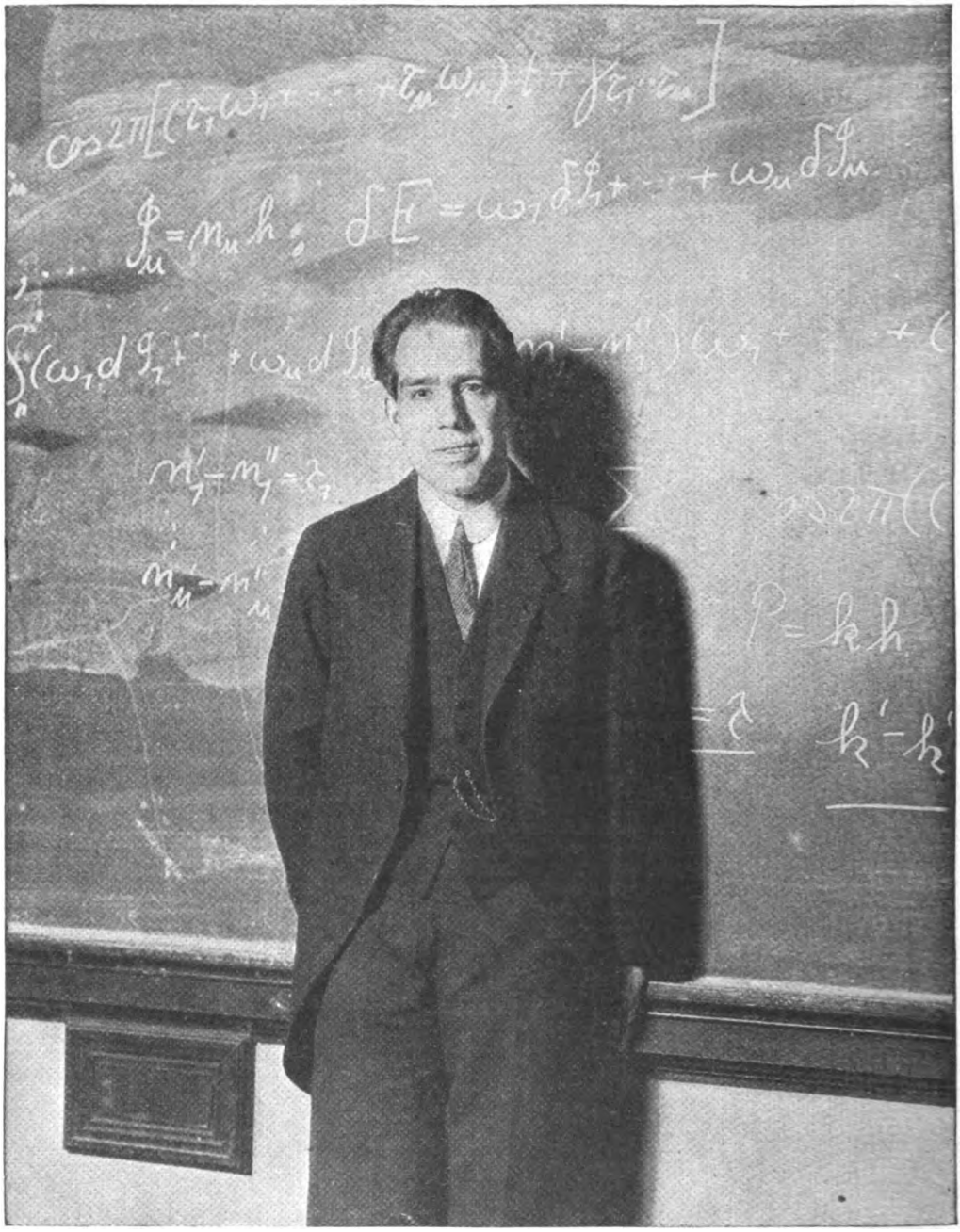

From a photograph made for POPULAR RADIO

A Foremost Explorer of the Electron Universe

Professor Niels Bohr, of the University of Copenhagen, has done more than any other scientist to lay bare the secrets of the spinning electrons that compose the atoms of matter. This photograph, made during Professor Bohr's recent lectures at Columbia University, shows a few of the mathematical equations which are necessary for the full exposition of his theories of how atoms are built and of how ether waves are produced from them.

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Popular Radio

VOLUME V APRIL, 1924 NUMBER 4

Bohr's New Theory of Atoms

Ether waves start from electrons and end on electrons. *Without electrons there could be no radio.* Atoms, too, are made of electrons. This article tells about the new and revolutionary conceptions of atomic structure that have attracted such profound attention in the world of science.

BY E. E. FREE, PH.D.

THE atoms of matter are so inconceivably tiny that there are more than 2,000,000,000,000,000 of them on the top surface of an ordinary pinhead.

Yet each one of these minute atomic specks contains a wonderful inner universe of its own. It contains, in fact, a whole solar system not unlike that greater system of the sun and the planets on which we ride so comfortably through the emptiness of space.

This knowledge that the atoms are miniature solar systems is new. It results, in the main, from the work of Professor Niels Bohr, a distinguished Danish scientist who has been lecturing recently in the United States.

For the radio engineer this theory has not only the interest which any atomic theory must have for every scientist but a special interest as well. It is the latest word of science about the electrical theory of matter. It is the newest news of the electron. And it is about to give us, so many scientists believe, the key to that great secret of the relation of ether waves (including both light and the waves of radio) to the kinds of electricity with which we are more familiar as electric charges and as electric currents.

The Bohr theories were originally reached, indeed, through the study of the ether waves sent out in the form of light rays from heated atoms; the light rays which make up sunlight or the light from the flame of a fire. But this way of approaching the theory has many difficulties for the student. Explanation will be easier if we consider, first, what the theory has to say about

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the make-up of the atoms of matter.

The theory embodies an idea of the atom rather different from that described recently in POPULAR RADIO by Sir Joseph J. Thompson.* The Thompson theory is a static one. It assumes that each atom consists of a central particle around which are grouped a number of electrons which occupy relatively fixed (or "static") positions so long as the atom holds together at all. The arrangement of these electrons in space is determined, Sir Joseph Thompson believes, by the usual electrostatic attractions and repulsions.

The new Bohr theory, on the other hand, is dynamic. It agrees with the Thompson theory in assuming the same ultimate parts for the atom; the central particle or nucleus and the electrons that surround it.

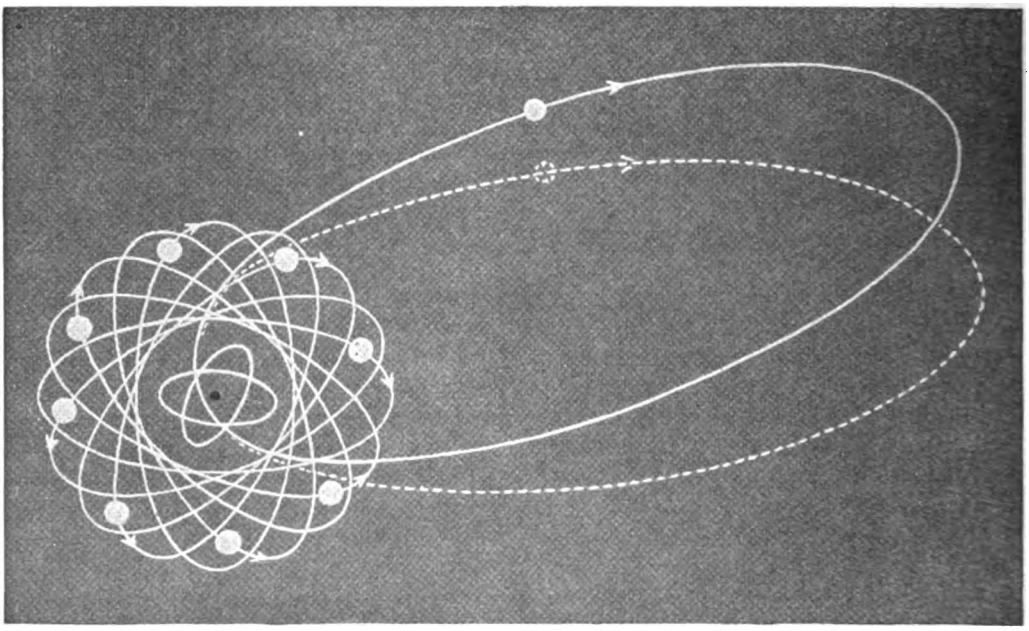
But Bohr does not believe that these electrons are stationary. Far from it. He believes them to be in rapid revolution around the central nucleus much as our earth is in revolution around the sun. That is why the model of the atom to which the Bohr theory leads is sometimes called the "solar system" model. It sees the atom as an assemblage of electron "planets" surrounding a nucleus as "sun."

Between these two theories, the static theory favored by Thompson and the dynamic theory proposed by Bohr, the weight of scientific opinion now inclines strongly to the theory of Bohr. There would be general agreement among scientists, presumably, that Bohr's picture of the electrons whirling dizzily around each tiny atomic sun represents the best present idea of science as to what atoms are really like.*

The best introduction to the Bohr

* "New Theories of How the Atom is Put Together," by Sir Joseph J. Thompson. POPULAR RADIO, vol. 4, pages 179-186 (September, 1923).

* This picture of the atom was applied to a common material—metallic copper—in an article in POPULAR RADIO for January, 1924, pages 41-48.



AN ATOM OF SODIUM, AS THE BOHR THEORY SEES IT

Two electrons (not shown in this illustration) occupy the two innermost orbits. Eight more electrons move in orbits of about the same diameter. The eleventh electron has a much larger orbit and this orbit gradually rotates, as shown by the dotted line. It is this outermost electron that is knocked off whenever a sodium ion is produced, as in the sodion vacuum tube.

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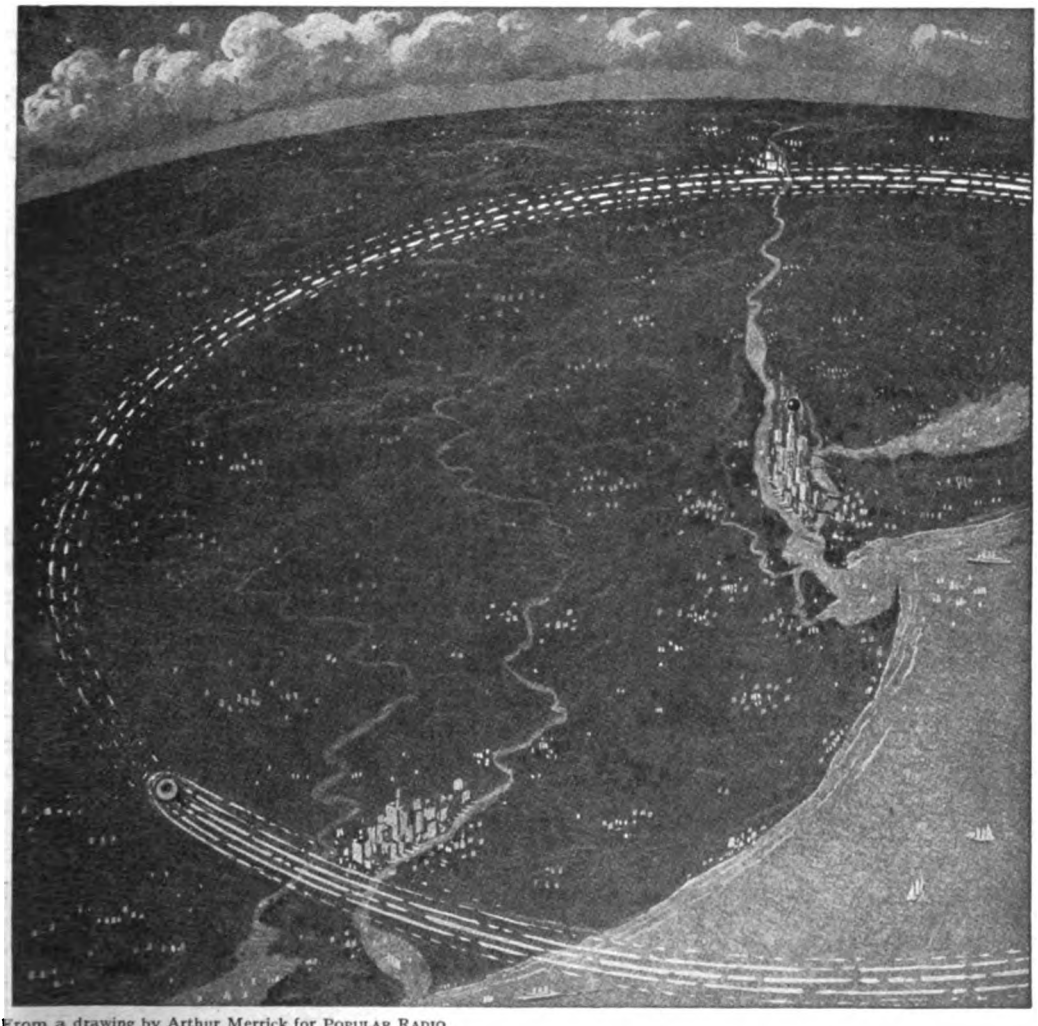

From a drawing by Arthur Merrick for POPULAR RADIO

WHAT A GIGANTIC HYDROGEN ATOM WOULD LOOK LIKE

If a single atom of hydrogen gas were magnified some two billion million times, the central nucleus of it would be represented by a little particle the size of a buckshot on top of the Woolworth Building. Around this would revolve a forty-foot balloon, representing the electron, the orbit of which would reach just beyond Philadelphia. Yet this is the simplest kind of atom; other kinds contain more electrons.

theory is the consideration of its model for the simplest known kind of atom—the atom of hydrogen gas.

This atom contains, everybody agrees, only two particles. At the center is a simple particle that serves as the atomic sun. Around this revolves a single electron. The hydrogen atom is a solar system with only one planet.

This planetary electron is an ordinary electron, just like those that are familiar to us in the theory of the vacuum tube and of other electric devices. In the vacuum tube the electrons are free and shoot about alone through the space inside the tube. In the hydrogen atom the electron is bound to the atomic nucleus. If it leaves the nucleus the atom no longer exists as an atom.

The central nucleus of this atom is

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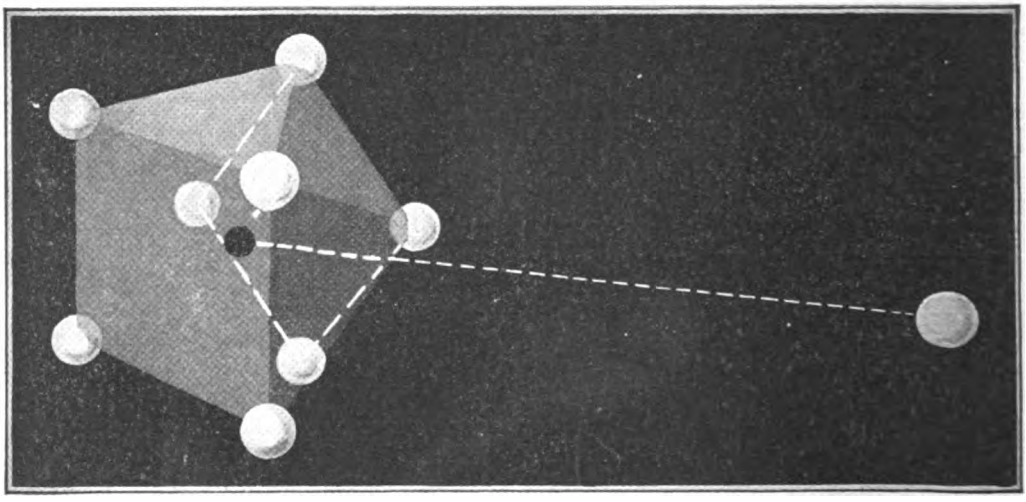
a particle somewhat less familiar to radio engineers than is the electron. Scientists call this central particle a "proton." Sometimes it is called a "positive particle" or a "positive electron" for it possesses, we discover, a permanent charge of *positive* electricity exactly equal in amount to the charge of *negative* electricity possessed by the ordinary electron.

About the real nature of this positive particle or proton that serves as the atomic sun we know practically nothing. Nor do we know, for that matter, anything about the real nature of the electron. These two particles, the proton and the electron, we must merely take for granted. We know that they exist. We know that they are the building stones of matter. We know that they lie at the root of most (if not all) of the phenomena of electricity. What they really *are* we do not yet know, and it is futile to disguise this ignorance.

But, assuming that these two particles are the universal constituents of all kinds of atoms, let us try to visualize the simplest known combination of them; that is, the hydrogen atom, which is composed of one particle of each kind.

This atom is far too small, of course, for us to dream of actually seeing it, even with the most powerful imaginable microscopes. But let us imagine that we possess the magical power of enlarging things as much as we wish and let us enlarge a hydrogen atom until we *can* see it. Or, as we are going to compare it to a solar system, let us enlarge it until the orbit of the electron planet in the atom becomes comparable in size to the orbit of our earth. We can then compare the proton of the atomic system with our sun and the electron with our earth.

Nor will this electron (in the enlarged atom) seem so very different from our earth. It will be a sphere, somewhat flattened at the poles as our earth is, and with a diameter of about 6,500 miles as compared with the 7,900-mile diameter of our earth. It will be moving around the proton in an orbit not unlike the earth's orbit, though the electron moves, as we shall see, very much faster than the earth does.



A DIFFERENT MODEL OF THE SODIUM ATOM

This is the "static" model of the same atom the "dynamic" model of which is shown on page 320. The electrons are supposed to occupy relatively fixed positions instead of being in orbital revolution. Most scientists do not favor this static model, but prefer the dynamic, or Bohr, model. Either model will explain the ionization in the sodion tube, as the eleventh electron is far out from the rest of the atom in both models.

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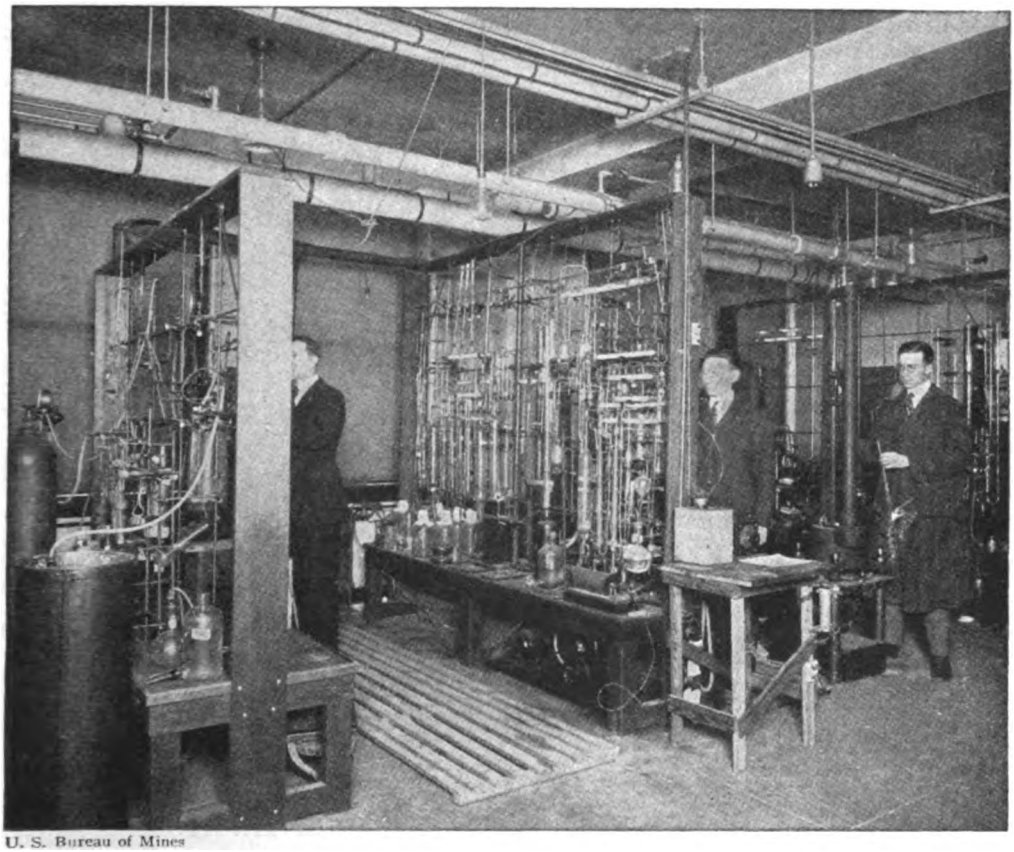

U. S. Bureau of Mines

FREEZING THE ELECTRONS IN ATOMS

The arrangement of the electrons in an atom determines the properties of substances. The two simplest atoms, hydrogen and helium, are the hardest ones to freeze. In this laboratory of the United States Bureau of Mines these two gases are used to produce temperatures hundreds of degrees below zero; at these super-freezing temperatures copper wire has almost no resistance for electric currents.

But it is when we turn to look at the central sun of this enlarged atomic system (that is, at the proton), that we see the greatest difference between the astronomic solar system and the atomic one. In the astronomic system the sun is much larger than the planets. The sun's diameter is, in fact, more than a hundred times the diameter of the earth.

In the atomic system this is not true. The proton is *smaller* than the electron. It has, we believe, only about 1/1850 the diameter of the electron. In our enlarged hydrogen atom where the electron is 6,900 miles in diameter, the central proton will have a diameter of *less than four miles.*

At first sight this is a very surprising fact. How can this tiny proton act as a nucleus to hold the vastly larger electron in its atomic orbit?

There are two reasons for this. One is that the attractions between the electron and the proton are electrical instead of gravitational. They depend, therefore, on the relative *charges* of the bodies, not on their relative weights.

The second reason is that the proton, though exceedingly tiny, is tremendously dense. In common language we would say that it was very "heavy" for its size. It is, in fact, billions of times "heavier" than the densest lead.

For this reason we can find a better

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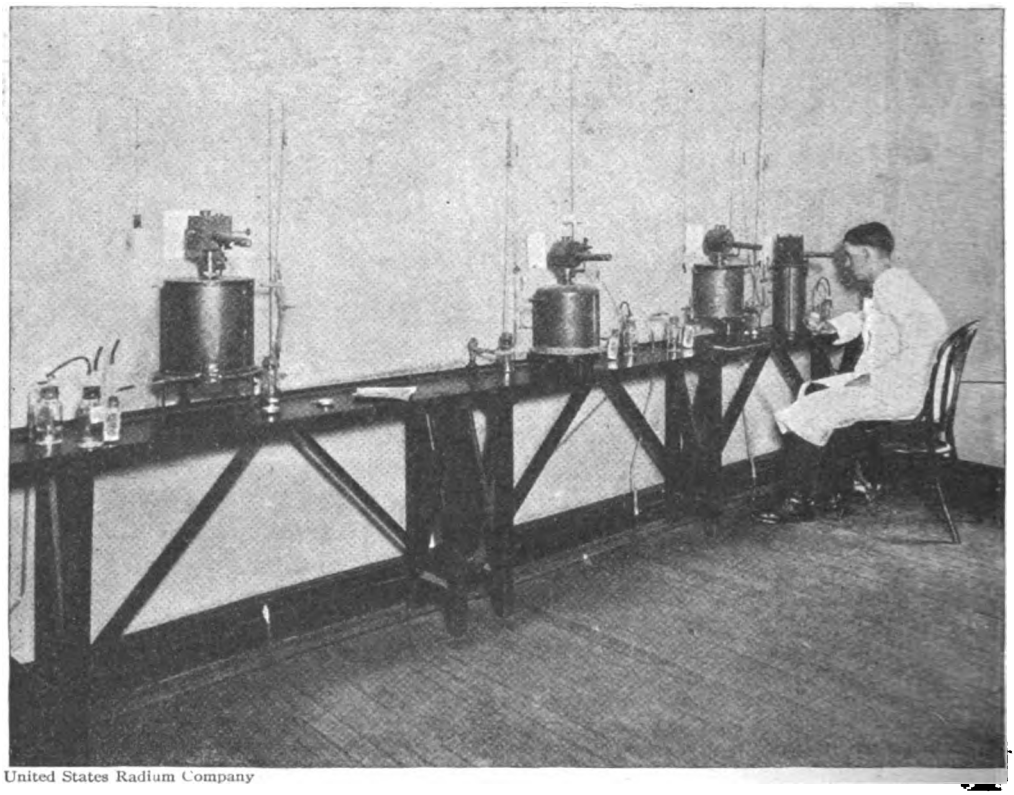

United States Radium Company

MEASURING RADIUM BY THE EXPLOSION OF ITS ATOMS

The atoms of radium are continually blowing up. Whenever they do so they send out ether waves that are like the waves used in radio, but much shorter. The strength of radium preparations is determined by catching these ether waves (in the apparatus shown here) and measuring their intensity. The exploding radium atom also shoots out some of its contained electrons.

model of the hydrogen atom than is given by our earth and our sun. This better model would consist of a small but very heavy sphere at the center, say a lead buckshot. Around this would revolve a much larger but much lighter sphere, say a gas-filled toy balloon. The buckshot represents the proton; the toy balloon represents the electron.

But we will need a rather unusual toy balloon to represent the electron, for if the proton is the size of a buckshot the electron-balloon will have to be about *forty feet* in diameter. And so inconceivably small is the actual system of the atom that the distance between the buckshot and the forty-foot balloon, if we keep accurately to our scale for the model, will be *nearly one hundred miles.*

This is the model of the Bohr theory for the hydrogen atom. A small lead buckshot about a quarter of an inch in diameter represents the proton. Let us assume this placed on top of the Woolworth Building in New York City. Around this there sweeps continually in a great circle the forty-foot balloon that represents the electron. On each revolution it passes just beyond Philadelphia on one side and a little short of Albany on the other.

This represents, as I have said, the simplest known atom. The atoms of the other chemical elements differ from it only in that they are more complex. All of them consist, we believe, of the

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same ultimate particles; the protons and the electrons. But the other atoms, beyond hydrogen, contain more than one each of these particles.

The atom which is next in simplicity to hydrogen is the atom of *helium.*

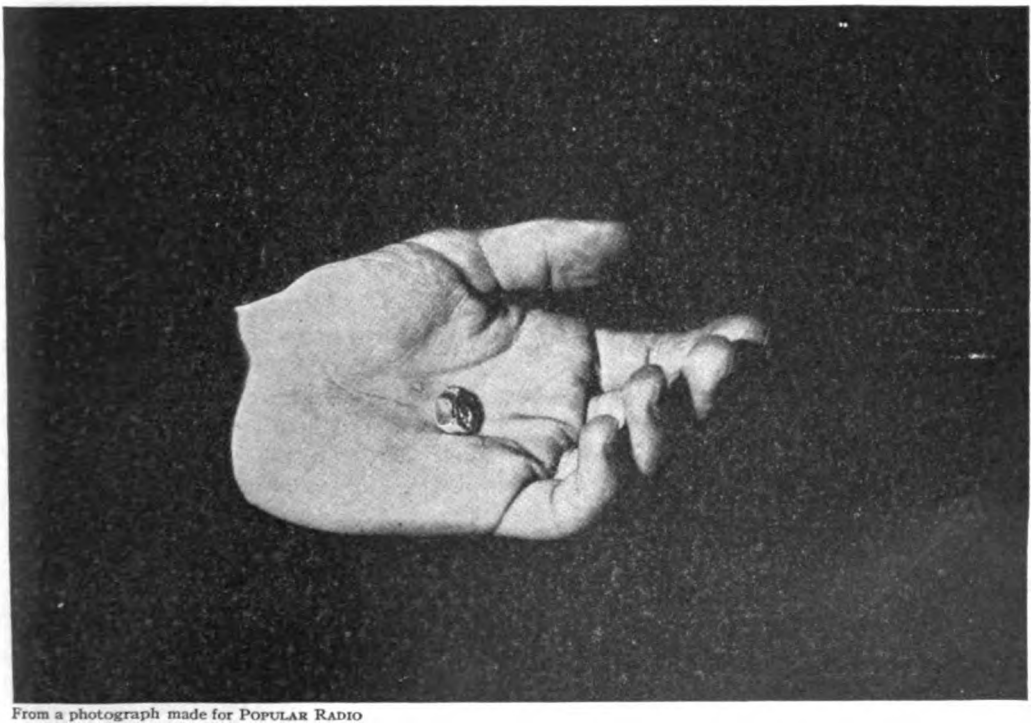
Helium is the newly discovered gas that is now used, you remember, to inflate airships. It is the only non-explosive gas that can be used for this purpose and the proposed North Polar trip of the great navy airship, the *Shenandoah* is expected to be carried out by its aid.

The atom of helium has two electron planets instead of the one possessed by the hydrogen atom. It has, also, an atomic sun that is considerably more complex than the simple one-proton nucleus of the hydrogen atom. The helium nucleus is believed, in fact, to contain four protons. But it contains something else in addition to the four protons. It contains two electrons.

The atomic sun of the helium atom is, then, a permanent aggregate of *four* protons plus *two* electrons. So far as we know these nuclear electrons are just like any other electrons. They are merely bound, in some fashion which we do not understand, inside the nucleus of the atom. Around the whole of this compound nucleus revolve the two planetary electrons.

The other atoms, still more complicated than helium, are built up in an analogous fashion. More protons and electrons are added. All of the protons go into the nucleus. Some of the electrons do the same; others of the electrons become additional planets.

The third atom, for example, is that of the metal, lithium. It contains *six* protons, all of which are in the nucleus;



From a photograph made for POPULAR RADIO

A RADIO SET MADE OF THIS METAL MIGHT COST A MILLION DOLLARS

This is the most expensive metal in the world, Iridium. This piece of it is worth over $300. But its atoms have two valuable properties; the metal is hard and at the same time it resists corrosion. This would make it useful for electric contacts in radio sets—if it were cheaper.

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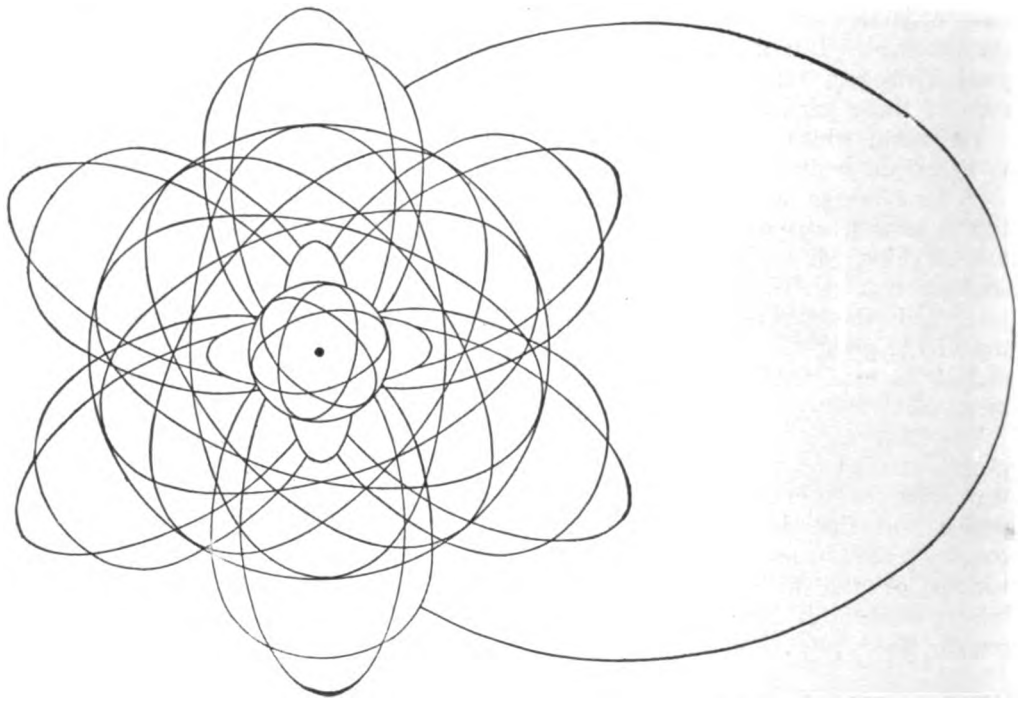

EVERY ATOM OF A COPPER WIRE LOOKS SOMETHING LIKE THIS

This diagram shows a few of the orbits occupied by the 29 electrons in each atom of metallic copper. Each orbit contains an electron that moves with speeds that may exceed 39,000 miles a second. There are billions of these atoms in the smallest visible copper filing that you scrape off a wire when soldering your radio set.

and six electrons, three in the nucleus and three more revolving around it as planets. The fourth atom in the list, that of the rare element beryllium, possesses eight protons and four electrons in the nucleus, with four additional electrons as planets.

And so on through the entire list of the chemical elements until we reach the last and most complicated atom of all, that of the radioactive metal uranium. This atom contains 92 electron planets revolving around a nucleus that consists of about 180 protons combined with about half as many electrons. The atom of radium is almost as complicated, having 88 electron planets and about twice as many nuclear protons. It is probable, in fact, that the tremendous complexity of these last atoms is the reason for their radioactivity. They are so unwieldy that occasionally they blow up, shooting out the electrons and other particles that produce the radioactive effects.

Throughout the list of atoms it is the *planetary* electrons that determine the ordinary properties of substances. The nucleus is hidden away at the center of the atom and protected. The outer electrons are the atom's contact with other atoms and with the world. It is, for example, the number and arrangement of the planetary electrons that make gold different from lead, that make oxygen the life-giving gas that we breathe while chlorine is a corrosive and poisonous one. It is the continual revolution of these innumerable billions of electrons inside the atoms of matter, each keeping to its own orbit and attending strictly to its own business, that gives to every smallest fragment of the universe the aspect that it has.

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Our bodies, for example, consist of some twenty different kinds of atoms. Each atom has its accustomed group of electron planets; one planet each for the atoms of hydrogen (which make up a large part of our body); twenty-six planets each for the atoms of iron, which are, so far as we know, the most complicated kind of atoms really necessary to life.

The human body is really nothing but a maze of flying electrons. Man is motion. If the revolution of the electrons in your bones and muscles and blood corpuscles should stop you would instantly disappear. It is probable, in fact, that you would explode with the most inconceivable violence.

The speed of the electron planets in their orbits is so great that it transcends all human experience. In a copper atom, for example, some of the electrons move with a speed of more than 39,000 miles a second.* Even the slowest of them have, we believe, a speed of nearly 10,000 miles a second. One of these slowest electrons could fly, if it were loose, more than twice around the earth in less time than it took you to read this sentence.

And such speeds mean power. Everyone knows that if the earth hit something and stopped, the energy released would turn every fragment of our globe into white-hot gas. The same kind of thing would happen if the revolving electrons in the atom were stopped. If the energy of electron motion in your body were suddenly released the explosion would not only dispose of you but it would wreck the neighborhood. There is more energy in the first joint of your thumb than in the explosion of a hundred pounds of dynamite.

Is this energy of any importance in radio?

Undoubtedly. Radio receivers and radio transmitters are alike composed of atoms; the atoms of copper in the antennas, the atoms of air in between the plates of the condensers, the atoms of other substances in the insulating materials out of which the panels and frames and supports are formed.

The radio waves go out from electrons; either free electrons or, perhaps, the electrons of the atoms themselves. The conversion of electricity to radio waves in the transmitter and of radio waves back to electricity in the receiver, both are done by atoms and by electrons.

How, then, can we hope for adequate understanding of the real basis of radio until we have learned about these whirling systems of electron planets that make up the copper of our wires, the plates and filaments of our vacuum tubes and even, we must not forget, the bones and membranes and nerve-cells of the human ears that we must use when we listen to our radio receivers?

* The structure of the copper atom is described in more detail in the article in POPULAR RADIO for January, to which reference has already been made.

THE *motions of the electrons in the atom are not only responsible for the nature of matter and for the form of the universe. They control, also, the production of ether waves such as the waves of light. It is electron motions that produce the colors of flames; the red-fire, for example, of political parades. By examining the light that they send us we can study the behavior of electrons off in the most distant stars, millions of millions of miles away. It is electron motions that produce radio waves also. What the Bohr theory has to say about these relations between ether waves and electrons will be told by Dr. Free in a following article in* POPULAR RADIO.

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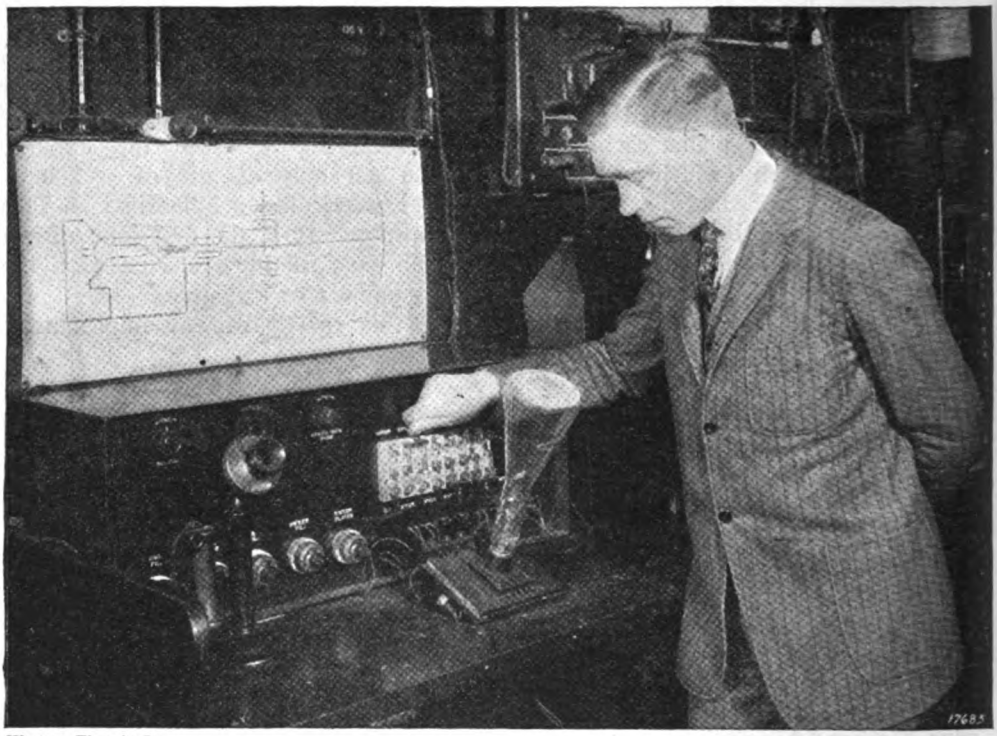

Western Electric Co.

THE MAN WHO PERFECTED THE OSCILLOGRAPH

An interesting laboratory snapshot of Dr. J. B. Johnson studying the wave form of an oscillating circuit as it traces itself on the chemically prepared bottom of the oscillograph tube which he has developed and which is described in this article.

The Electron Pencil for Studying Radio Circuits

How can one *see* a radio wave? How do the engineers determine just what is the shape of the wave train in a radio circuit? This authoritative article tells how these phenomena are examined by the use of that remarkably ingenious instrument—the cathode-ray oscillograph. Like so many other features of radio, the secret of this instrument is the behavior of the marvelous little electrons.

By PAUL FINDLEY

IN the days before high, board fences were eliminated from the general landscape and before the advent of the automatic sprinkler, doubtless you have seen a small boy after finishing his task of sprinkling the lawn draw fancy designs on the painted board fence with the stream of water by wabbling the nozzle of the hose.

This is very similar to what happens in the cathode-ray oscillograph except that the stream, instead of being water, is made up of tiny electrons. And instead of the designs being made on a painted, board fence they are made on the flattened end of the tube which is coated with a chemical substance making the point of contact between the

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stream of electrons and the coating a luminous spot. Instead of the nozzle being wabbled by a guiding hand, the stream itself is swayed back and forth by electric attraction. The deflection of the stream of electrons is proportional to the force exerted upon it and therefore, by measuring its movements on the screen, it is possible to determine the action of the electrical forces in a piece of apparatus.

For instance, in radio broadcasting it is important that the audio-frequency voltage which modulates the radio-frequency output shall be large enough fully to load the transmitter, yet not large enough to overload it. Direct evidence of this is given by connecting the cathode-ray oscillograph in such a way that while the radio output moves the spot up and down the audio input moves it sideways. According to the theory of modulation, the radio current should vary uniformly from zero to a maximum as the voice voltage moves from one extreme of its cycle to the other.

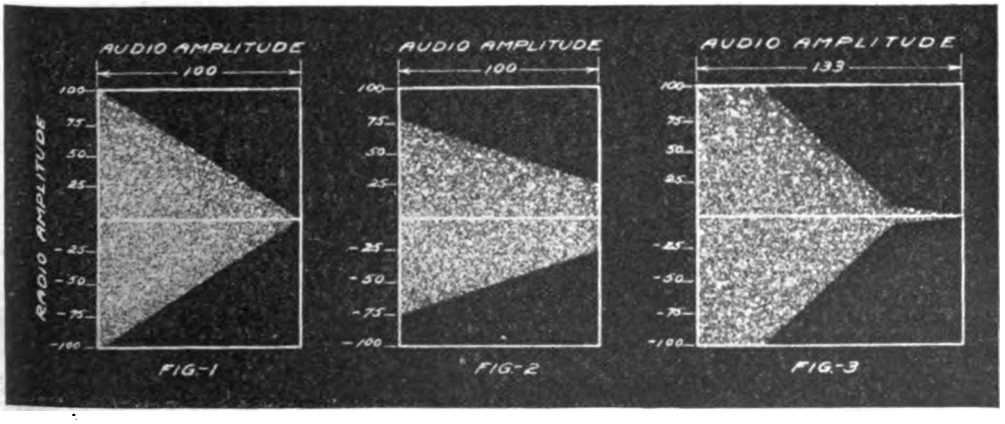
Figure 1 shows this condition, or 100 percent modulation.

Figure 2 shows a lower amount, corresponding to a softer passage in the music.

Figure 3 shows over-modulation, which happens when some ambitious operator "crowds" his transmitter in a try for some new distance record. Over-modulation means distortion and dissatisfaction from his regular near-by audience.

The principle of the cathode-ray oscillograph was discovered by Braun twenty-five years ago, and the tube has always been known by his name. In Braun's tube, however, the electrons were produced by a high-voltage discharge between metal terminals, through the remnants of gas left in the tube. Some of the electrons went through a tiny hole in the terminal plate and struck the end of the tube making a spot of light where the stream of electrons ended. If an electric voltage was applied between the plates the stream would be deflected toward the positive plate and the spot of light moved across the screen.

The original Braun tube had two major limitations. The gas left in it became gradually exhausted and had to be renewed, while the voltage required to operate it was from 10,000 to 50,000 volts direct current. The apparatus necessary to generate a current of this voltage and its maintenance was expensive and it was also dangerous for the operator to handle.



OSCILLOGRAPH PICTURES OF RADIO MODULATION

Figure 1, at the left, shows perfect modulation; the audio-frequency and radio-frequency currents are properly proportioned to each other. Figure 2 shows incomplete modulation and Figure 3 shows over-modulation. Oscillograph pictures like these can be used to control the operation of broadcasting stations.

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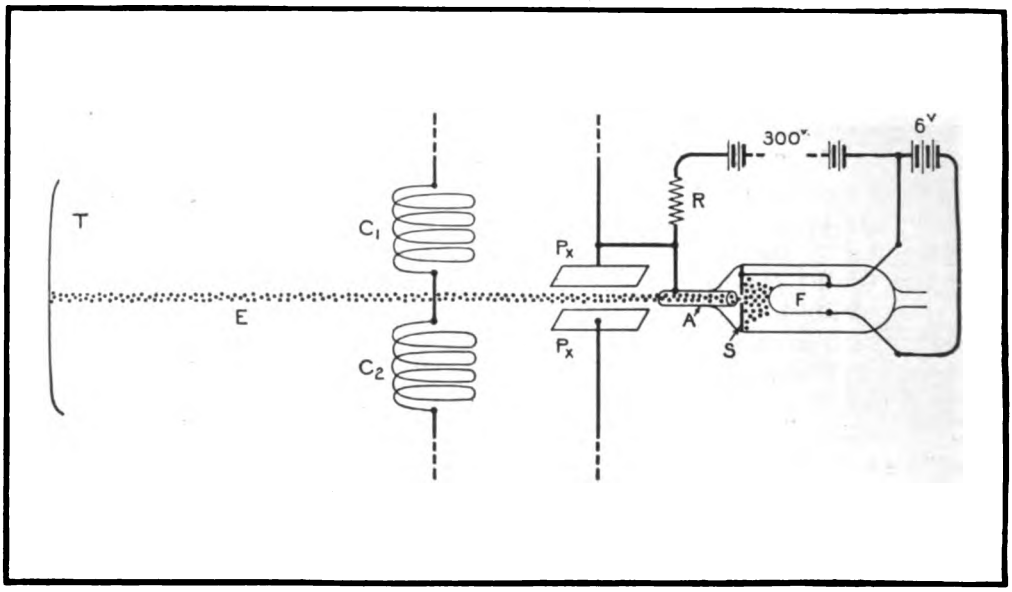

HOW THE OSCILLOGRAPH WORKS

FIGURE 4: *The electrons are produced from the filament F and pass through the charged metal tube A in the form of a thin stream or pencil. Electric deflections are produced by the plates Px and magnetic deflections by the coils C_1 and C_2.*

In addition the tube itself was not stable. The electrical characteristics varied with the amount of gas in the tube and sometimes the electron stream was falsely deflected by negative charges collected on the glass walls of the tube. For these reasons the Braun tube was never used as much as it deserved when its advantages were considered.

The development of the vacuum tube, however, opened up a way to obtain the stream of electrons more easily by the use of the heated filament. In Figure 4 is shown the filament, which is heated by a six-volt battery as in the ordinary vacuum tube. Another battery built up of small radio "B" cells provides 300 volts between the filament and the other electrode A. This electrode is in the shape of a little tube. The voltage at which it is maintained draws off the electrons from the filament. They pass through the hole in the plate S, and down through the tube A. From there they shoot on down between the plates Px, to the end of the vacuum tube where they strike the chemical coating of the screen T, making a bright dot. To simplify matters only one pair of plates Px, is shown in the diagram. There are really two pairs, the other pair being at right angles to the first and used to swerve the beam at right angles to the motion produced by the first pair of plates.

One plate of the pair Px, has a lead which passes through the glass to a terminal. The other plate is connected to the tubular electrode A, and from there to a terminal outside the tube. In this way when a voltage is put across the two plates the stream of negative electrons will be swerved toward the positive plate.

When it is desired to measure a current instead of a voltage, two small coils of a few turns of wire are placed on opposite sides of the tube. These are shown as C_1 and C_2 in Figure 4. The magnetic effect of a current in these coils deflects the electron stream in a direction parallel to the plane of the coils and the luminous spot will be moved as before.

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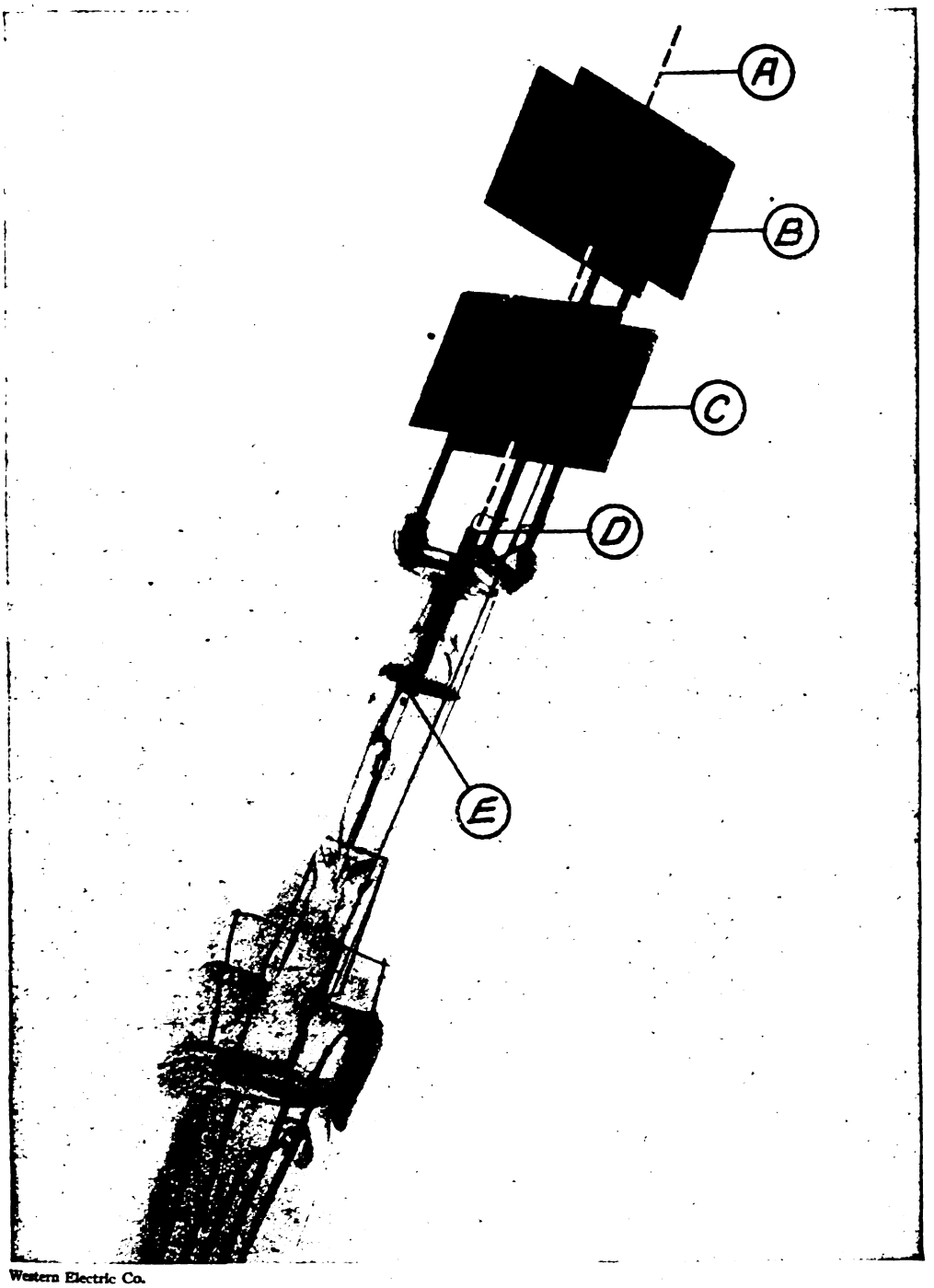

Western Electric Co.

HOW AND WHERE THE ELECTRON PENCIL IS PRODUCED

These are the working parts of the oscillograph. The electrons are produced by the filament E and pass through the tube D, forming the electron pencil A. B and C are the two pairs of charged plates that swerve the stream of electrons to one side or the other in correspondence with the forms of the impressed electric waves.

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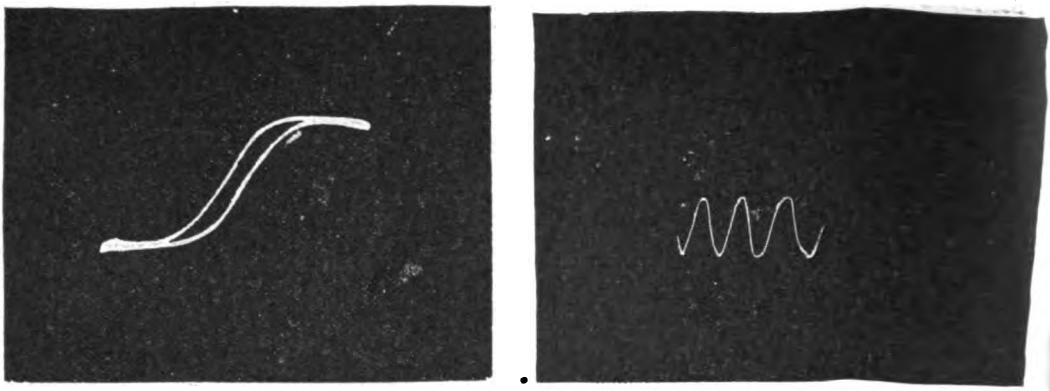

WHAT YOU SEE ON THE SENSITIZED END OF THE OSCILLOGRAPH TUBE

At the left is the appearance of a "hysteresis loop" that is produced by a sample of magnet iron. At the right is the wave form of an ordinary, 60-cycle alternating current.

The cathode-ray oscillograph thus described (as developed by Dr. J. B. Johnson of the Western Electric Company) overcomes the disadvantages of the original Braun tube. The adoption of the heated filament does away with the necessity of maintaining a high voltage between the filament and the other electrode. The elements are so designed that the electrical characteristics of the tube are maintained independent of the pressure of the gas in the tube.

It was found in the development of this tube that when it was exhausted to a very high vacuum the individual electrons of the stream separated. This stream of electrons shooting out through the tubular electrode A, resembles very much the stream of water with which the small boy draws his designs on the board fence. The electrons separate just as do the globules of water, making the electron stream relatively wide where it strikes the end of the tube.

Of course, the boy making his figures on the fence does not care whether the pencil he is drawing with is an inch in diameter or a foot. But when you are intending to calculate the action of an electric current you must use a sharp pointed pencil. So a way had to be found to focus a stream of electrons down to a very fine point.

Consequently, the engineers made up a tube containing a small amount of argon, an inert gas. First they exhausted the tube of all the air possible, even baking the glass while it was being exhausted so as to release from the glass all the gas which would be freed by the heat generated during operation. Then the argon gas was introduced.

Every gas is made up of separate molecules, each of which has a comparatively large nucleus positively charged with electricity which is surrounded by a number of negatively charged electrons held to it by electric attraction. The free electrons shoot down the tube at a velocity of some 6,000 miles a second and when one of them hits one of these gas molecules which is moving at the rate of only ¼ of a mile a second the force of the collision knocks off one or more electrons from the molecule.

Before the collision the positive charge of the nucleus was neutralized by its ring of negative electrons but when some of these electrons are knocked off, the nucleus, now positive, begins to attract free negative electrons. As these nuclei are heavy in comparison with the flying electrons, they are simply buffeted around by the latter and they stay in the line of the electron stream where

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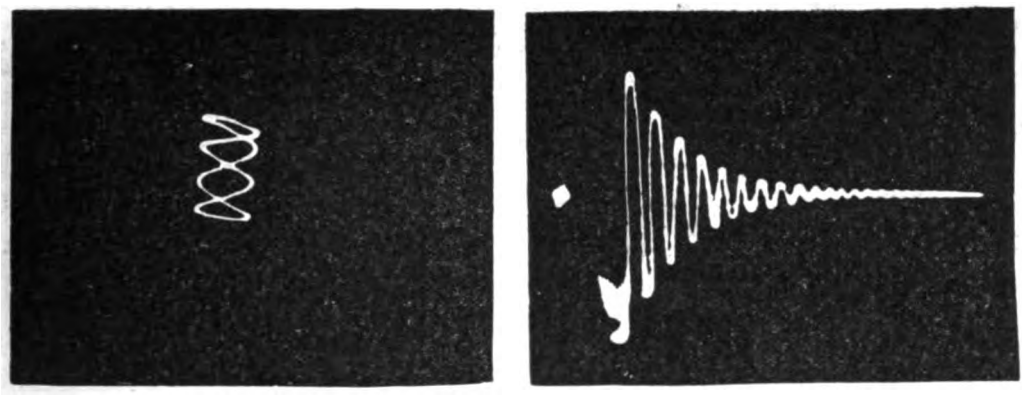

TWO MORE PICTURES FROM THE OSCILLOGRAPH

The figure to the left shows an exact frequency match between 100-cycle current and 400-cycle current. This figure will persist on the tube end so long as neither of the two frequencies is changed. To the right is an oscillograph picture of a damped wave train produced by the discharge of a condenser through an inductance.

they were formed. Therefore, along the whole length of the electron stream, there is a line of positive nuclei which attract the free electrons and hold them in the straight and narrow path in spite of the repulsion between electrons which tempts them to spread out.

Furthermore, the dislodged electrons, shooting off in all directions, soon fill the space outside the stream with negative charges which repel the flying electrons, thus tending, also, to keep them in their own path.

In order to prevent the bombardment of the filament by positive ions, which would destroy its oxide coating and thus render it inactive, the filament is sealed in the glass mounting tube. To prevent the ions from striking the filament when they come through the hole in the plate S, the filament is bent in a circle as shown in the photograph. The filament is made of ribbon instead of wire, which leaves just an edge exposed to these ions.

The great advantage of the cathode-ray oscillograph lies in the fact that the stream of electrons forms a nearly weightless pointer, the movement of which will follow accurately the changing conditions in the circuit to which it is connected. By avoiding mechanical inertia, as it does, it is capable of recording frequencies up to millions of cycles a second.

The instrument can be used in many ways. When only one set of the deflector plates (Px in Figure 4) is used, the electrical potential to be measured causes the luminous spot to become a bright line whose length is proportional to the amplitude of the voltage wave. If now another voltage varying with time is applied to the other pair of plates the beam will be swept across the field and its wave form can be seen. Thus, by speaking into a telephone transmitter one can "see himself talk."

The familiar hysteresis loop of magnetized iron can be shown vividly with this oscillograph. The magnetizing current moves the spot from side to side and the resultant magnetism in the sample moves it up and down. In the Western Electric laboratories of the Bell System, such a set-up has been made by winding the magnetizing coil on a fiber tube, into which is slipped a thin strip of the material to be tested for its magnetic properties. The fiber tube is so placed that the end of the sample is near the oscillograph tube, where its magnetism can swerve the flying electrons.

By connecting each pair of deflecting plates to alternating currents of different frequencies, the spot will trace out

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curious patterns. If the frequencies are steady, and one is an exact multiple of the other, the pattern will be stationary, otherwise it will change as the phase relation of the current changes. One of the figures shows a comparison of 100 and 400 cycles, but the ratio between the two may be much greater.

For two currents differing widely in frequency, the pattern may be too long for its ends to appear on the coated end of the tube but the fact that it is steady shows that one frequency is an exact multiple of another. Thus the carrier wave of a broadcasting station may be amplified and impressed on one set of deflector plates, while a locally generated frequency impressed on the other set of plates is adjusted to match with it. The local wave is then matched with another local frequency at say, 1/100 its frequency and this in turn is "stepped down" to a frequency which can be measured easily, thus using the oscillograph as a wavemeter.

The chief value of this cathode-ray oscillograph is to get quick visible indications of what is going on in an electric circuit. It can be used to explore a situation and to ascertain, roughly, what is going on as a first step to devising measurements which will be more accurate. For example, after the apparatus is set up, hysteresis loops can be taken very rapidly on one sample of iron after another, as against a half-day each by the more accurate "point-by-point" method. Also for demonstrations before students, this device shows what is happening in any oscillating circuit with a clearness and vividness that are most convincing.

Pacific & Atlantic

ANOTHER "MATCHBOX" RECEIVER

Edmund Campbell of Washington, D. C. used, for the coil of this tiny set, the magnet winding from an ordinary bell buzzer, with the iron core removed. The coil, the simple crystal detector and the four binding posts are all mounted on the inner half of the box.

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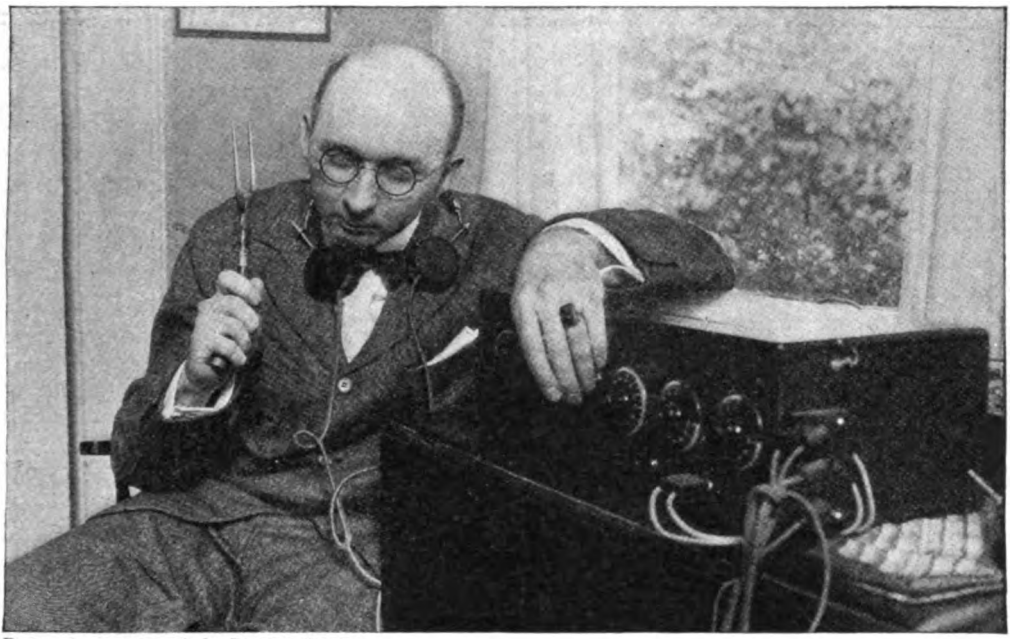

From a photograph made for POPULAR RADIO

DON TUNES IN ON THE RADIO GAME—WITH A TUNING FORK

"My neighbor Jim Brunner let me turn a few knobs myself and look at a lot of pretty electric lights inside," admits the author. "I was a hopeless idiot from that evening on." This picture was made at that stage in Don's career as a fan.

How I Built a $12 Crystal Set

THOUGH 34 YEARS OLD

The Editor asked Don Herold to build a simple crystal receiving set, following the instructions prepared by the Bureau of Standards at Washington and published in POPULAR RADIO, and then to write his experiences. Here they are.

By DON HEROLD

WHEN the radioptimistic editor of this incomprehensible magazine asked me to build a simple crystal receiving set he said: "A twelve-year-old boy can do it with $12 worth of materials, simply by following the instructions set down by the Bureau of Standards at Washington. The Bureau wrote the instructions so they could be understood by twelve-year-old boys."

After reading the instructions, I decided I would like to see the twelve-year-old boy they keep at the Bureau of Standards as an example of a standard twelve-year-old boy. He is a whole lot smarter than I used to be when I was twelve years old, or have ever been since.

"If you are handy with tools—" started the instructions.

I am not.

However, I resolved to read on, and, if humanly possible for an old man of thirty-four, to go ahead and build the little crystal set.

I made this resolution in spite of the

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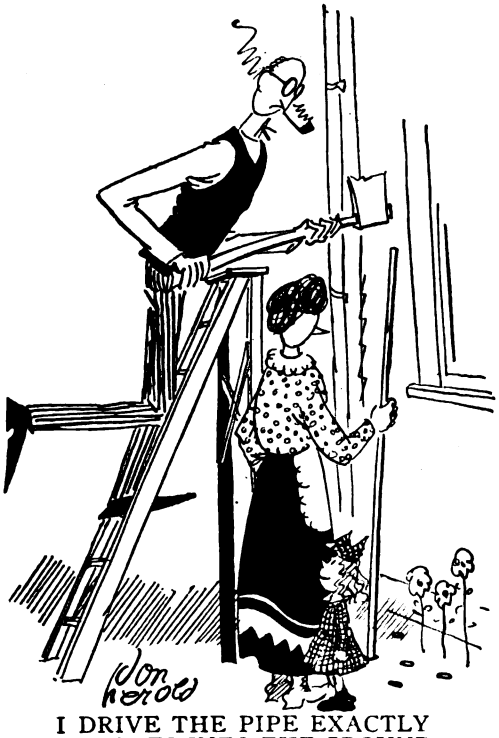
fact that I was not the least bit interested in radio and knew that I would not want a radio receiving set in my house even after I got it built. I had heard a static recital at a friend's house in Brooklyn one night and, though this friend had insisted that his set was not "working very well" that night, I had made up my mind then and there what I thought about radio.

The first thing I did, on starting to build my set, was to skim through the instructions hurriedly to get a general idea of what I was up against. I saw immediately that my main problems were going to be:

1. How to get up in a tree to hang the other end of the antenna.

2. How to get a hole bored through the window sill through which to bring the lead-in wire.

3. Where to find a round oatmeal box with which to make a tuner.



I DRIVE THE PIPE EXACTLY 14 INCHES INTO THE GROUND

—and at exactly that point I strike solid rock fully 150,000 feet thick. That was not in the book of rules!

4. Where to find a piece of iron pipe for an outside ground.

The first problem was practically insurmountable. It has been at least fifteen years since I have been up a tree. I looked over all the trees in our yard and there wasn't one of them that I could possibly climb, not even with the aid of a ladder, and even if I had had a ladder I would not have known how to get it up against a tree. After considering this tree problem carefully, I gave up the idea of building a receiving set, gave it up entirely. Then it occurred to me that our trees needed trimming and treating and that if I had some expert tree surgeons come over and do this work, they could hang my antenna for me while up one of the trees.

My antenna thus cost me $78.

The problem of getting a hole through the window sill or frame was solved by getting a carpenter to come over and fix up a lot of screens which did not exactly need fixing.

This hole cost me $37.50.

I canvassed the neighborhood for a round oatmeal box, but everybody on our street eats oatmeal that comes in square boxes, so it looked as if I were not going to have a tuner. Finally I said to my wife, "We will have to change oatmeal. You will have to subscribe to round oatmeal for a while."

I thought the piece of water pipe for the ground would be fairly easy to find. I was sure there must be a piece under our back porch. Three years ago when we remodeled our house, we tore out $1,000 worth of old plumbing and put in $2,000 worth of new plumbing just like it, and I recall walking over long pieces of water pipes, piles of them, for months. Finally, they had hauled this old pipe away and I was sure that I could find it somewhere on the outskirts of town, providing that piece was not under the back porch, which it was not. After a week or so of looking under the back porch, I stayed at home from

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the office one afternoon and drove all over the outskirts of town looking for a piece of pipe on all the dump heaps in the city directory. There were plenty of old furnaces and some fine old bath-tubs, but not a foot of water pipe. Late in the afternoon I went to the plumber who had hauled away at least $1,000 worth of old pipe from my house, and said:

"Have you an old piece of second-hand pipe that I can use for an outside ground for a radio set that I am building? Just any kind of old pipe will do, from six to eight feet long."

"No, we haven't a single piece of old pipe on the place, but a piece of new pipe that long won't cost you very much."

"How much?" I said.

"About ninety cents," was the answer.

"Well, the Bureau of Standards at Washington and the editor of POPULAR RADIO haven't allowed me anything for old pipe, so I can't take it. I have got to keep the cost of my set within $12." I started to walk out.

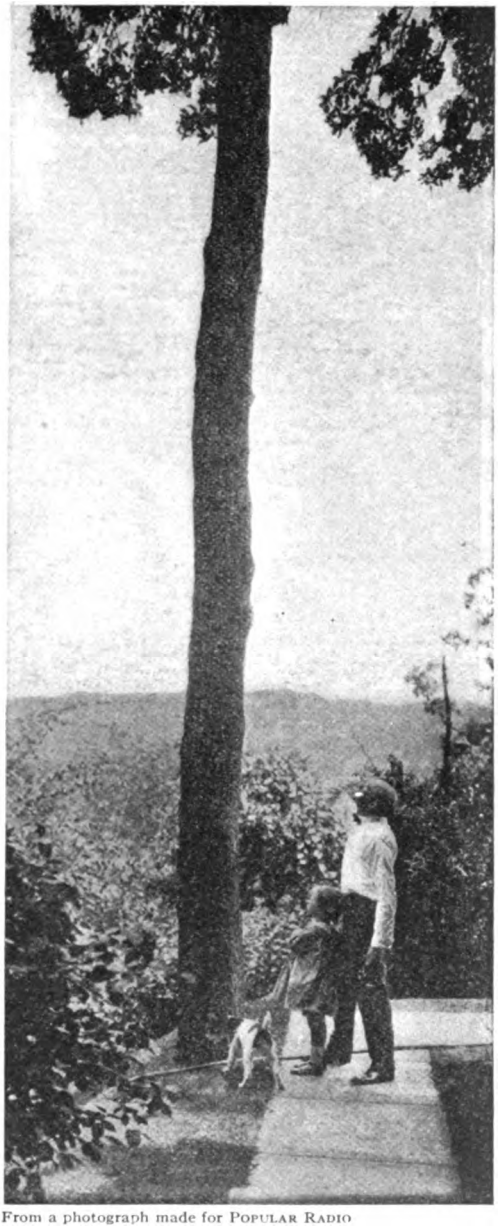
"Wait a minute," said the kind-hearted plumber. "I believe there is one piece of old pipe out in the back yard. You can have it if it is still there."

We found the piece, and I took it home, intending to drive it three to six feet in the ground, more probably three.

Counting my time at $100 a day, whether I always get it or not, that hunk o' pipe cost me $50, to say nothing of wear on my automobile, driving over piles of old tin cans, ash heaps and the like.

I got up on a stepladder with an axe and had Mrs. Herold hold the iron pipe while I drove it from three to six feet into the ground.

I had driven it exactly 14 inches when I struck a stratum of solid rock fully 150,000 feet thick. I tried the pipe in several different places, but the deepest I could get it was 14 inches. Here was something that was not in the book of rules!



From a photograph made for POPULAR RADIO

HOW COULD I GET UP THAT TREE TO HANG UP THE ANTENNA WIRE?

That, I saw immediately, was to be the first of my main problems.

I had heard that Jim Brunner, one of my neighbors, had a radio set, and that evening I went over to ask him if 14 inches was deep enough for an outside ground pipe.

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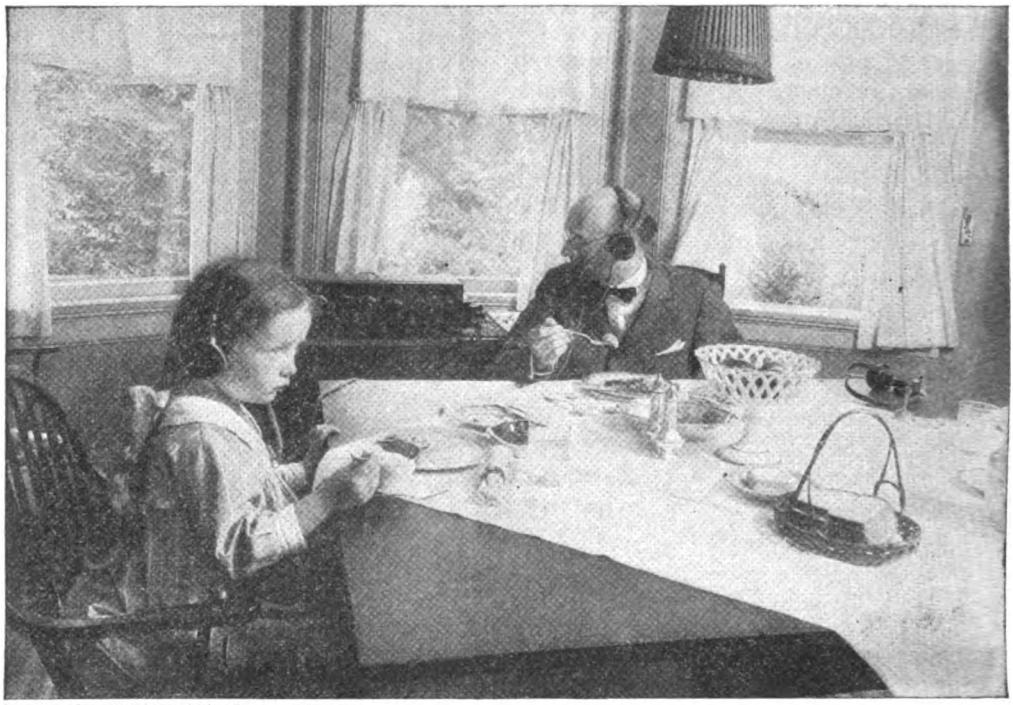

From a photograph made for POPULAR RADIO

THE FAMILY NOW HAS CAULIFLOWER EARS FROM USING THE HEADPHONES OVERTIME

I am now "collecting cities" with more zeal than I have put into anything since I used to collect stamps.

"Oh, I think so," said Jim. "Are you putting in a set?"

"Yes," I replied. "Doing it all myself. I'm going to write an article about it."

"Fine," he said. "Come in and listen to my set. We are getting some good stuff tonight."

"Naw, I don't want to hear it," I replied. "I'm not interested in radio."

"Well, come on in and hear this set of mine."

"I suppose it isn't working very well tonight."

"No, not very. Still, you can hear a little. Come on in."

I followed him into the house reluctantly and he jammed a set of headphones on my head.

It wasn't bad at all. Really, it was pretty good.

There was good singing and a couple of fine orchestras, and a lecture on gladioli which we listened to until we discovered it was on gladioli and then switched to a violin recital somewhere or other. I stayed a couple of hours, without having to.

When I reached home, I re-read the instructions for making that crystal set. I was quite enthusiastic about the headphones and other parts that could be bought ready to work, and I made a list of the ingredients of the outfit and resolved to push the set to completion the following evening.

The next night I slipped over to ask Jim Brunner a few questions, and the first thing I knew it was nearly twelve o'clock and we were trying to get long distance broadcasting stations, and getting a few. Jim let me turn a few knobs myself. There were a lot of pretty electric lights inside.

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I was a gonner. I was a hopeless radio idiot from that evening on.

Need I tell you how I didn't build the crystal set at all? Need I tell you how I got Laurence M. Cockaday, the technical editor of POPULAR RADIO, to come out with a car full of contraptions, and put me in an outfit of his own designing, and how thrilled I was to have a great radio engineer running around my house in his shirt sleeves while I sat and smoked?

"What do you like best about radio, Mr. Cockaday?" I asked, hoping to get something of technical interest to put into my article for the readers of POPULAR RADIO.

"The bedtime stories," he replied.

As the installation neared completion we were as interested in guessing what we would first hear on it as we used to be in guessing what the baby's first word would be.

"I hope it isn't 'The Land of the Sky-Blue Water,'" I said.

"Here is something now," said Mr. Cockaday.

I listened.

It was "The Land of the Sky-Blue Water," just as I feared.

"Don't worry," said Mr. Cockaday. "You may not hear that again for a month."

We have now had the set for a month. The house has never been struck by lightning, so I don't know whether 14 inches is deep enough for a ground or not. But it probably is. I don't know the idea of all those electric lights and thingamajings inside the box on my dining room table, but I expect to learn, as I now read POPULAR RADIO instead of using it under the short leg of a chair, and when I get Zion City, Ill., I feel as if I had invented radio myself. I am "collecting cities" with more zeal than I have put into anything since I used to collect stamps. The whole family stays at home evenings now and remains up late, afraid to miss something by going to bed.

We all have cauliflower ears from wearing headphones overtime.

If anybody knows anybody who wants to buy $12 worth of parts for a crystal receiver set, I will sell them for 50 cents on the dollar. I figure my radio enthusiasm is going to cost me thousands before I die, so what is $6?

It has been a long time since I was 12 years old, but I will soon be there again, with a radio set in the house.

Mrs. Herold is yelling that she has tuned in on an exceptionally good concert in Philadelphia.

D. H. signing off.

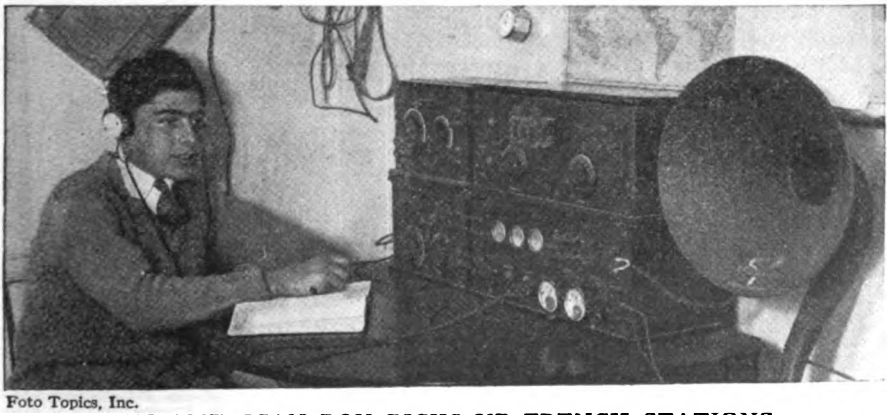

Foto Topics, Inc.

AN AMERICAN BOY PICKS UP FRENCH STATIONS

Dave Tyneberg, a 17-year old fan of New York, recently listened in on two stations in France (F8AI and F8BP) within six minutes of each other. He used a Reinartz circuit.

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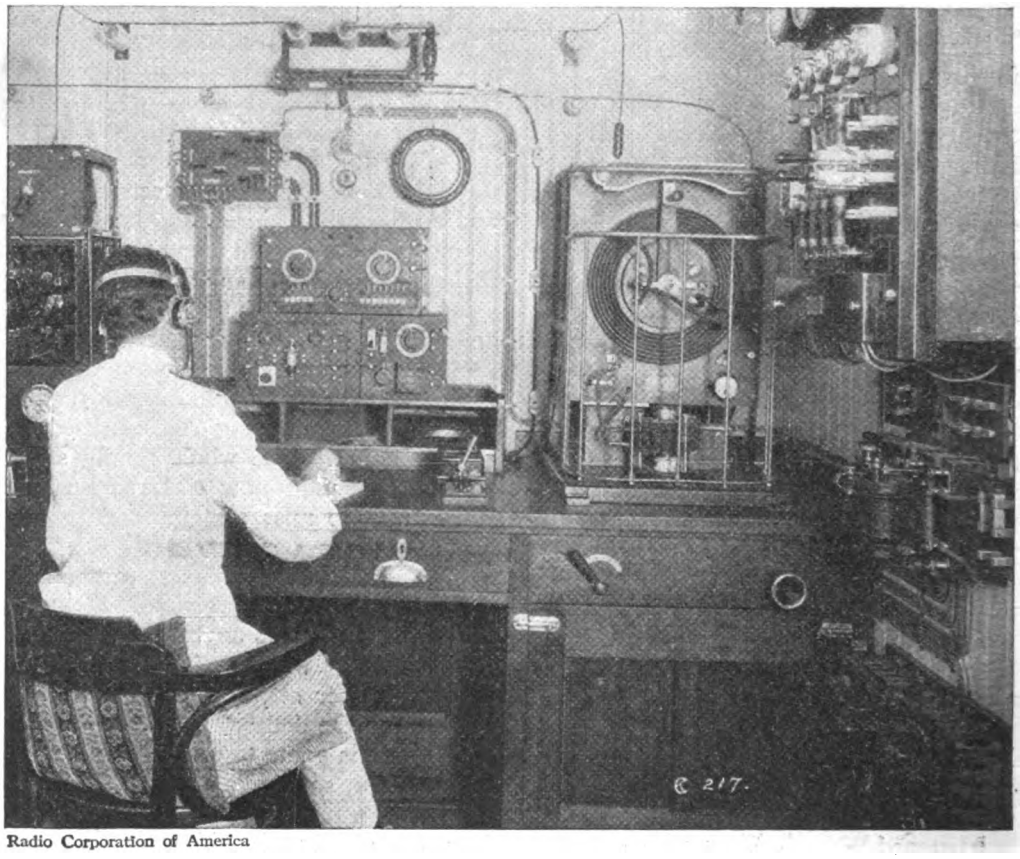

Radio Corporation of America

A QUENCHED-SPARK TRANSMITTER

This is the type used generally aboard ship for commercial traffic. In this transmitter the antenna is excited inductively and both the antenna circuit and the closed oscillatory circuit are tuned to the same wavelength.

How the Antenna Is Energized

Article No. 8

This article tells of some of the different methods that have been used, since transmitting by radio was first accomplished, to excite the antenna with the necessary high-frequency currents to produce radiation of energy into space

By SIR OLIVER LODGE, F.R.S., D.S.C., LL.D.

I WILL introduce this subject by an analogy.

There are two types of model or toy locomotives on the market; one type driven by potential energy, the other by kinetic energy.

The first is energized by twisting a rubber band, or by tightening a coiled steel spring. This is an example of *static energy,* stored in the shape of material strain.

The other type is energized by spinning a fly-wheel, much as a top is spun by a piece of string. The energy thus imparted

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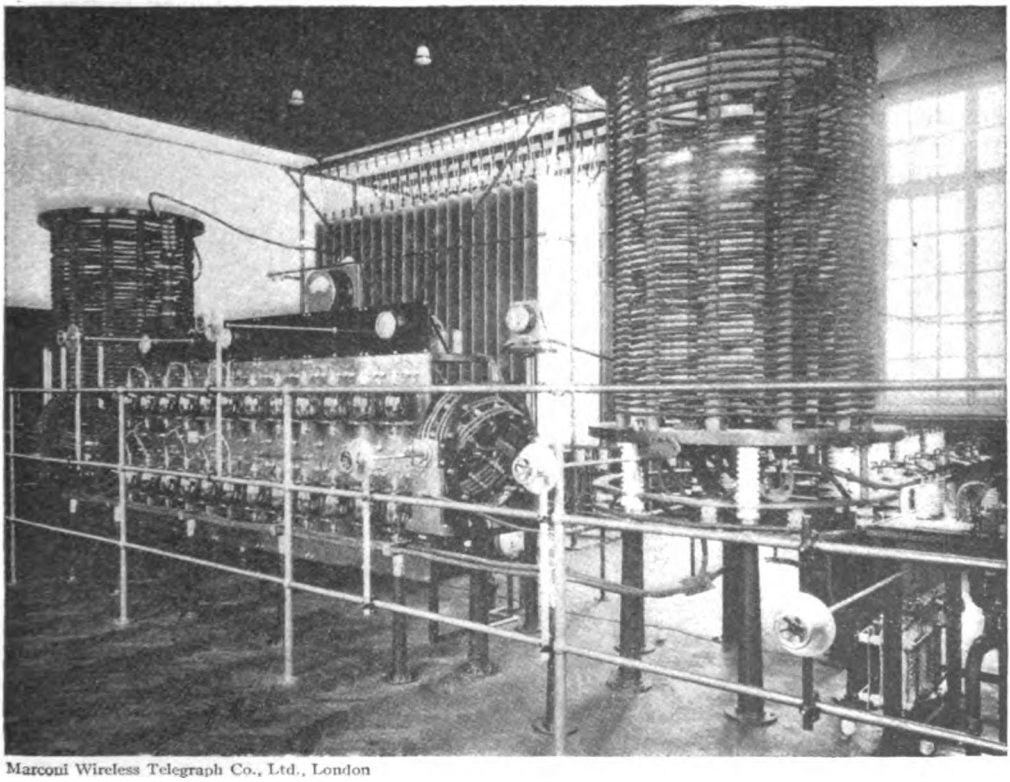
is *kinetic;* and by resting the axle of the fly-wheel on a larger wheel, the whole thing progresses slowly like a steam-roller, till the energy is exhausted.

The above is an example of two different types of mechanism. But a smaller difference can exist between the modes of excitation of a single type. Thus, take a violin string, for instance. There are two ways of making it sound; one by gently bowing it, or by blowing on it, or in some other way working up the oscillations gradually to a sufficient intensity. That is one way. The other is by plucking it; that is to say, by pulling it forcibly aside till it has acquired a certain amount of potential energy, and then liberating it, so that it may oscillate freely until all the stored-up energy is exhausted.

A string struck by a hammer, as in a piano, belongs to the kinetic type; for the energy is imparted in the form of motion; but it is imparted suddenly, and it virtually amounts to shock excitation.

Thus we have three different methods of exciting a string: a prearranged strain, or static method, illustrated by plucking; a gradual working up of the oscillations, as illustrated by some form of friction, or bowing; and the shock excitation method, illustrated by striking, as in a pianoforte. A harpist, presumably, is able to utilize the plucking method, but most wind instruments depend on the gradual working-up method. Whereas drums and triangles, and other such devices—the *batterie de cuisine*, as a musician has jocularly called it—are obvious examples of percussion.



Marconi Wireless Telegraph Co., Ltd., London

A VACUUM-TUBE TRANSMITTER

This type of oscillator employs the continuous-wave method of energizing the antenna. The antenna is being continuously vibrated electrically as in the case of the pipe organ, where a steady blast of compressed air is fed to the pipes to produce a sustained vibration of the air column.

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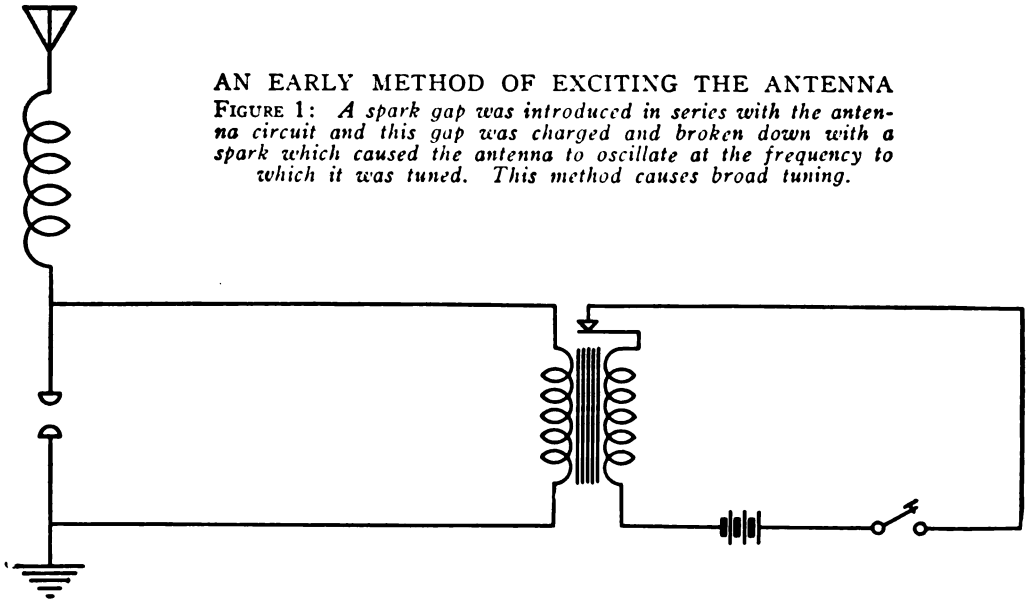

AN EARLY METHOD OF EXCITING THE ANTENNA

FIGURE 1: *A spark gap was introduced in series with the antenna circuit and this gap was charged and broken down with a spark which caused the antenna to oscillate at the frequency to which it was tuned. This method causes broad tuning.*

In exciting a radio antenna for transmitting, all three methods have been employed.

In the early days, working on the lines of Hertz, a spark gap was introduced directly into the antenna circuit; the antenna was charged positively, and the ground negatively, setting up a strain between them, until the air between the spark electrodes broke down or gave way electrically, and a spark or rush of current occurred between them, and oscillations began. That is the steady strain or prearranged method—by static electrification. And on this principle many Lodge-Muirhead stations were worked. It is a powerful method, but very difficult to tune out, since the initial jerk is rather violent. For some purposes this is a defect; for others it is an advantage. It was found to be a defect when arranged on the Great Eastern Railway line of steamers between Harwich and Antwerp; for though efficient, it was rather too efficient, and the government forts in the neighborhood found they could not always tune us out. With better tuning devices and, without a ground connection it could be done; but it was admittedly not easy.

The advantage of this mode of excitation is felt when tuning-out is *not* wanted; that is, when you desire every station within range to hear, to whatever wavelength it may be tuned. This is the case with an S. O. S. signal. And accordingly, for distress purposes, this method of excitation used to be employed on board ship, and possibly is still employed. It should be.

Then came the percussion method of excitation, utilizing what I used to call a "B spark"; that is the rush between the outer coatings of two Leyden jars whenever a spark takes place between their inner coatings. In that case the antenna was not pre-charged at all, but was charged with a rush or a blow, by the impact of the liberated induced charges in the outer coats of the jar or condensers employed. This method of shock excitation has been used a good deal; and the quenched-spark system is a modification of it, since the system is left to oscillate freely after receiving a blow, like a bell.

The third method of excitation, that by gradual working up, is now largely employed in various forms at continuous-wave stations. But so far as I know it was introduced at spark stations by Mar-

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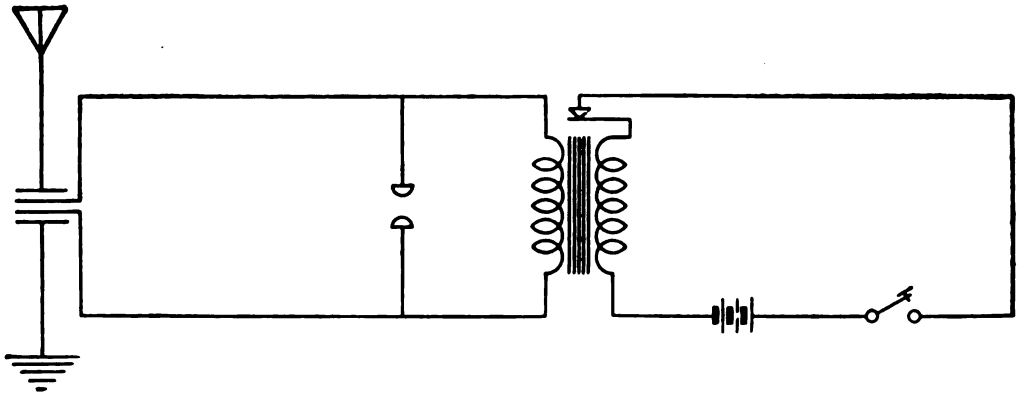
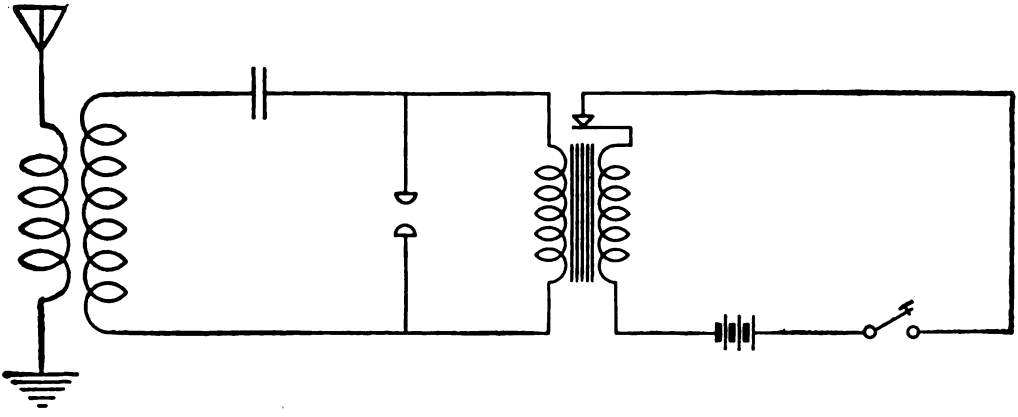


ANOTHER METHOD OF EXCITING THE ANTENNA

FIGURE 2: *By this method the antenna is energized electrostatically by means of a specified condenser, or what is really two condensers. This method found considerable use in the early days of "wireless."*

coni in his famous 7777 Patent, the antenna being excited inductively by an oscillating discharge in a closed circuit, to which it was coupled. Inductive connection at the receiving end had been patented before, *viz*, in my patent of 1897, but not at the sending end. For, though shock excitation is in that patent specification clearly foreshadowed, the continuous working-up method remained for future development, and when introduced was regarded as a decided improvement. For the oscillations do not in this case begin with any suddenness. They are gradually worked up from zero to a maximum, just as you may bow a tuning fork or a bell, instead of striking it; and thus excite a purer tone, more satisfactory to deal with, and easier to tune out when not wanted.

In this inductive method of excitation there is, in one sense, a prearranged static charge, at least at a spark station; but it is not a charge in the antenna itself. The potential energy is all in a closed local circuit. It is in the spark gap of this circuit that the strain is suddenly relieved, by fracture; and the oscillations which then begin are employed to stimulate oscillations in the inductively coupled



THE INDUCTIVE METHOD OF EXCITING THE ANTENNA

FIGURE 3: *Here the antenna is tuned by a coil which is coupled inductively to another coil in a closed oscillating circuit. If the coupling between the two coils is made loose enough, a much sharper wave will be radiated than is possible with either of the two previous methods.*

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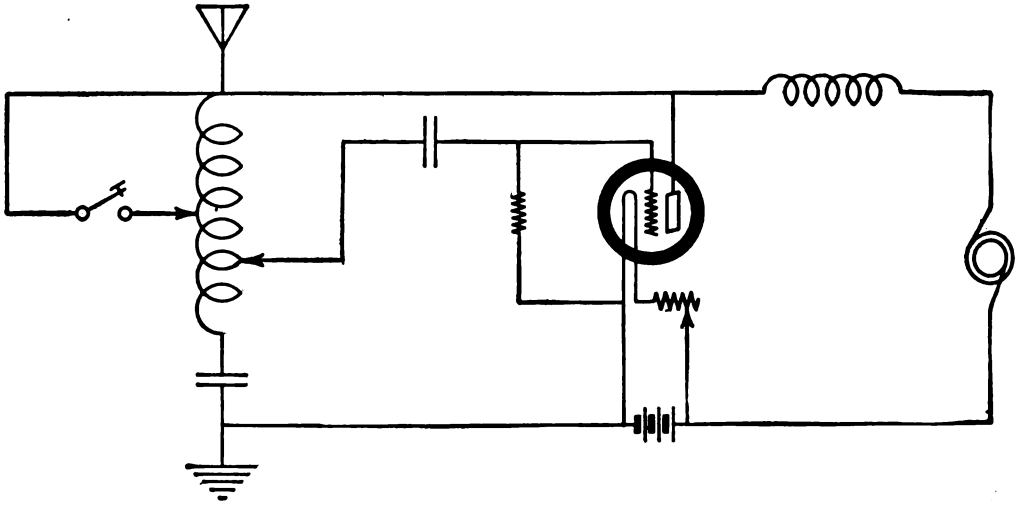
The Preceding Articles of This Series by Sir Oliver Lodge—

1. *How to Get the Greatest Efficiency out of Your Radio Circuits*.....March, 1923
2. *How to Get the Maximum Inductance in Your Coils*.....May, 1923
3. *The Ratio in Size Between Your Antenna and Your Coil*.....July, 1923
4. *Helpful Formulas for Designing Your Coil*.....September, 1923
5. *Practical Hints for Coil Calculation*.....October, 1923
6. *How to Calculate the Inductance of Your Coils*.....November, 1923
7. *Capacity Calculations—and Their Application to the Antenna*.....February, 1924

antenna. The spark in the primary may be quenched as soon as it has achieved its function, so that the antenna is left free to oscillate, without being hampered by anything like tight coupling to a closed circuit, which, as is well known, is liable to give waves of double periodicity; that is to say, a double kind of wave instead of a single one, a wave with two peaks, both of which it is difficult to tune out simultaneously.

The vacuum-tube and arc methods of excitation are representative of the continuous-wave system, like an organ pipe steadily blown from a bellows, and in these cases the oscillations are varied artificially by the operator, who makes them respond to the movements of his signalling key, the key being arranged sometimes so as to give variations in pitch instead of in amplitude, as in a flute or other keyed wind instrument.

The inductive method of excitation, whereby the energy is communicated to the antenna kinetically instead of by static strain, bears some analogy to the fly-wheel kind of model spoken of at the begininng of this article, as contrasted with the static energy of a wound-up spring. There is initial strain in the latter, or potential-energy case; there is none in the kinetic mode of excitation. The act of throwing a ball is an example of a kinetic method. The liberation of an arrow from a bow, or a stone from a catapult, is an illustration of stored potential energy suddenly liberated. So is the projection of a bullet by the chemically stored energy of gunpowder. But a magnetic gun, if such a thing is ever made, is more kinetic in its action. The two necessarily shade into one another, because suddenness is a relative term: but a pre-charged antenna, charged electrically until it reaches its bursting point, is a definite fact.



THE CONTINUOUS METHOD OF EXCITATION

FIGURE 4: *This is one of the circuits which are used with vacuum-tube transmitters such as pictured on page 341 which send out an extremely sharp wave. Where interference would be a serious disadvantage this is the best method to use.*

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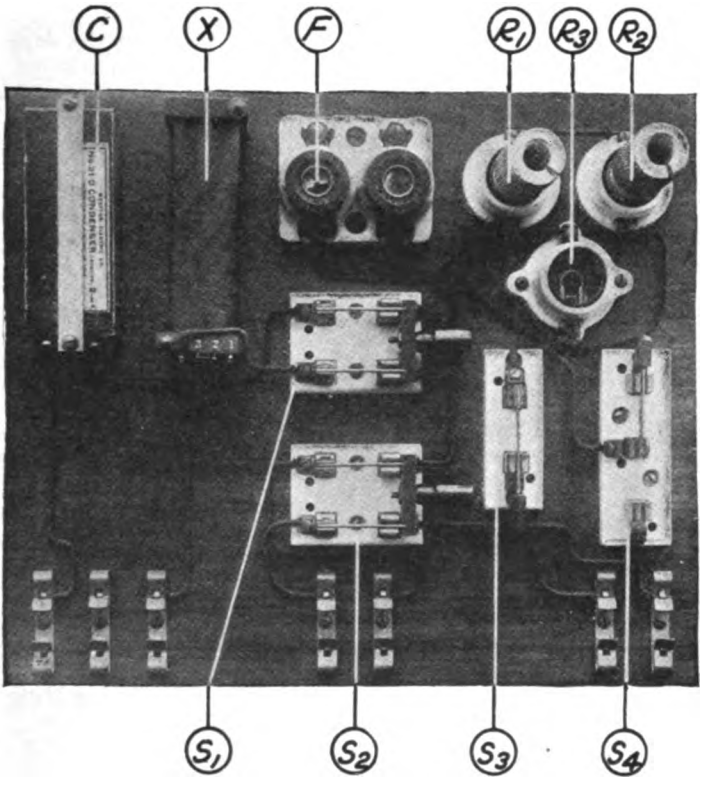

HOW THE COMPLETED PANEL APPEARS

FIGURE 1: *The wooden panel upon which are mounted the instruments for filtering the direct current and for charging the storage battery. All the apparatus is designated by letters which are also used in the text.*

A Novel Substitute for "B" Batteries

By F. F. HUMPHREYS

The radio fan whose home is equipped with a direct-current lighting service is fortunate, for he may eliminate the expensive short-lived "B" battery from his amplifier circuit and charge his storage battery at will. The scheme herewith presented for accomplishing this is entirely practicable, and will add considerably to the owner's enjoyment of his broadcast receiver.

HERE ARE THE ITEMS YOU WILL NEED—

1 wooden panel, 12 inches by 14 inches by ¾ inches;
1 piece of asbestos paper, 14 inches by 16 inches;
1 fuse block (double), porcelain;
2 10-ampere fuses;
3 lamp sockets, exposed terminals, porcelain;
1 single-pole double-throw knife switch, 15-amperes, porcelain base;
1 single-pole single-throw knife switch, 15-amperes, porcelain base;
2 double-pole single-throw knife switches, 15-amperes, porcelain base;
2 Western Electric A-6-116 telephone induction coils;
1 Western Electric 21-D telephone condenser, 2 mfd., with mounting strip;
6 Fahnestock binding posts, double connectors;
6 feet No. 18 gauge fixture wire;
necessary screws for mounting parts.

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FOLKS who dwell in the suburban towns and who subscribe to an electric lighting and power service, are almost invariably supplied with alternating current. But those who live in the large industrial and business centers are supplied with either alternating or direct current.

The facility with which alternating current may be transmitted from the power station to the remote subscriber through the agency of booster and distribution transformers, makes this service especially popular in the rural districts.

Direct current, on the other hand, is used extensively in some large cities for operating variable-speed machinery and where the distances of transmission are not too great. A very substantial percentage of the homes in New York, for example, are wired for direct current.

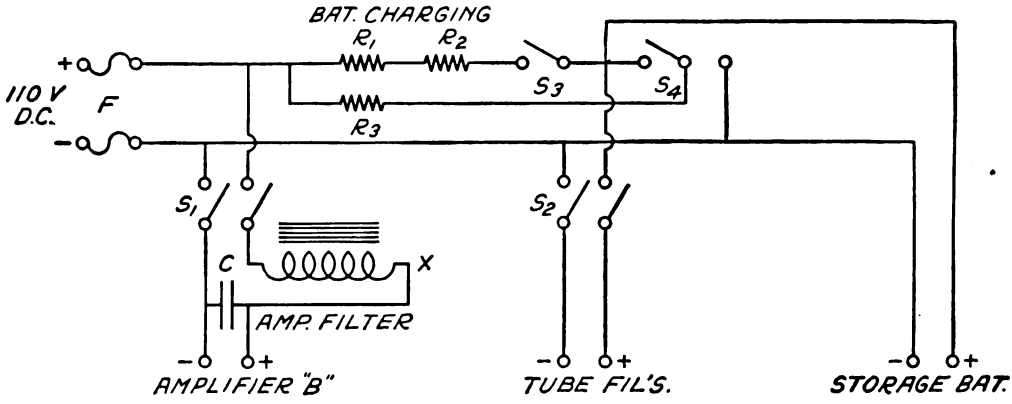
No doubt the safest if not the most convenient way to determine whether one's home is supplied with alternating current or direct current is to inspect the meter. This device measures the quantity of electricity used by the consumer and is usually located in the basement of his home.

The *alternating-current* meter is generally small, and enclosed in glass; the number plate on the face of the instrument gives not only its proper voltage and amperage but also the frequency of the current on which it has been designed to operate.

The *direct-current* meter is (in most cases) larger than the former type and somewhat resembles a common gas meter in appearance and proportions. Its mechanism is protected by a metal housing and the number plate bears the voltage and amperage capacities of the meter.

In case a Thompson watt-hour meter has been installed in the home, little or nothing may be learned from an inspection of it, as this instrument measures *both* alternating and direct currents. Should the radio fan be unsuccessful in determining the nature of the current with which he is being supplied from his observations, he may learn what he wants to know by getting in touch with his electric company.

But a simple electrical means of solving the problem is at the disposal of the fan. He may resort to the "salt-water" test. To make this test, it is merely necessary to immerse the exposed ends of two wires, brought from a lamp socket, in a glass of water in which a half teaspoonful of table salt has been dissolved. If, when the current is turned



THE WIRING DIAGRAM FOR THE PANEL

FIGURE 2: *The symbols on this diagram correspond with the letters on the photograph in Figure 1, so that the builder should have no trouble in making the proper connections.*

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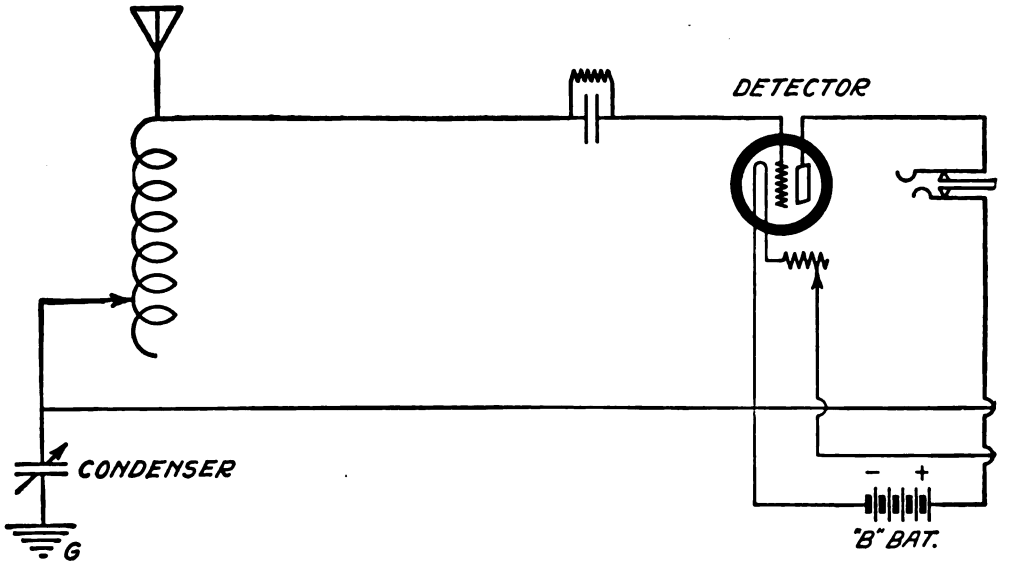

HOW TO CONNECT THE PANEL WITH A SIMPLE RECEIVING SET

FIGURE 3: *Of course, any receiving set may be substituted in place of this one with good results.*

on, bubbles form on both wires, an alternating current is passing between them. The appearance of bubbles on one or the other of the immersed wires indicates direct current. When performing this test care should be taken to keep the ends of the wires well apart at all times, as, if they should accidentally come together, a short circuit would result. Such an occurrence would require the replacement of a burned-out fuse in the switch or fuse box and might cause the observer serious misfortune. When connecting the test wires to the lamp socket, it is advisable to make use of an attachment plug similar to that employed in conjunction with portable reading lamps or vacuum cleaners.

The Difference Between Direct Current and Alternating Current

For the benefit of those fans who are not familiar with the essential differences between direct and alternating current, a few words here may be helpful.

Direct current differs from alternating current primarily in that the former flows continually in one direction, whereas the *alternating* reverses its direction of flow periodically. Direct currents are obtained from batteries and D.C. generators, while alternating currents are produced by A.C. generators or "alternators," as they are frequently called. The expressions A.C. and D.C. are contractions of *alternating current* and *direct current,* respectively.

In the course of his experience, the radio fan has doubtless been impressed with the importance of connecting the "B" battery in the plate circuit of his amplifier or detector tube in the proper manner. That is, he has learned that the *positive* terminal of the battery must be connected toward the *plate* element of the tube and that the *negative* terminal of the battery should be wired to the tube *filament.*

If these connections are reversed, the tube becomes inoperative.

This being the case, it is obvious that only a positive voltage or potential can be applied to the plate of the tube effectively (for receiving). As the alternating current supplied to homes reverses its direction of flow at a frequency of approximately 120 times a second (60 cycles a second) and as the introduction of such a current into the plate circuit of a vacuum tube would produce the same effect as reversing the "B" battery connections to the tube at an equal frequency, alternating current *cannot* be used to supplant the plate battery.

We may, however, replace the battery with a direct-current generator successfully.

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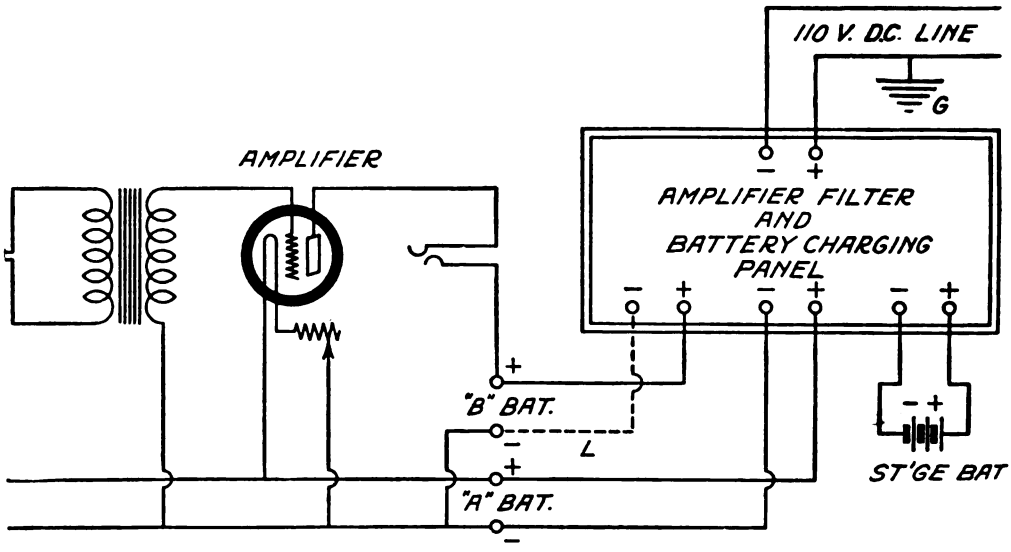

How Direct Current Is Generated

Although the direct current led into the home from the street mains is practically free from fluctuations, it is not nearly as smooth as that developed by a battery of any type. This is due to the fact that the generator at the power station which produces the current, feeds it to the mains through a mechanical agency known as a "commutator."

Batteries depend on chemical action for current production and the currents developed by them are therefore devoid of noticeable irregularities.

As an explanation of commutation, it may be said that the power produced by the generator is delivered by its rotor or armature to the mains through a commutator by means of brushes brought into contact with the latter. The commutator is composed of many small metal segments arranged in cylindrical fashion about one end of the rotor shaft and to these the current-generating coils of the armature are directly connected. As the rotor revolves, the energy generated in its armature coils is drawn off at the proper moment by the brushes which are fastened to the stationary frame of the machine. This process gives rise to a series of uni-directional audio-frequency current pulsations which are blended into each other in a manner such as to produce an almost even direct current.

Now, if generator current is supplied directly to the plate circuit of a receiving tube, a strong "commutator hum" will be perceptible in the headphones. This is due to the passing of the generator commutator segments beneath the brushes and may be sufficiently loud to drown out the strongest signals picked up by a receiver. Therefore, before the direct-current lighting system can be successfully used to supplant the "B" battery, the commutator hum must be eliminated from it. This is accomplished by "filtering" the plate current fed to the tube.

What the "Filter" Does to the Current

The effect of inserting a filter between the plate circuit of a vacuum tube and the line, is to smooth out the irregularities in the current supplied to the tube, just as adding a flywheel to a combustion engine serves to steady its operation. Because of *electrical inertia* the filter gives the circuit to which it is added a sort of stability and, therefore, any slight tendency toward a variation (of current) in the circuit is overcome. In order that the filter be effective, it must possess a certain amount of capacitance and reactance.

The filter and charging panel illustrated in Figure 1, was constructed by the writer about one year ago. It was used in conjunction with a tuned-plate regenerative receiver and a two-stage audio-frequency amplifier. The panel was used instead of "B" batteries with the set over a period of eleven months and during that time gave highly satisfactory service. The original intention was to replace also the detector "B" batteries with filtered D.C., but it was found that better results were obtained by applying this scheme to the amplifier only. It is probable that losses were introduced into the plate circuit of the detector tube by associating it with the lighting system of the house. A 6-volt storage battery was used to light the filaments of the tubes and this was recharged from the direct-current supply whenever necessary. The panel was hung at the side of the operating table by means of two iron brackets.

The various instruments on the panel shown in Figure 1, have been similarly arranged in symbolical form with their connections in Figure 2. The 110-volt line connections are made fast to the input terminals of the fuses, F. Current is admitted to the amplifier filter through the double-pole single-throw knife switch S1. The filter consists of a Western Electric No. 21-D telephone condenser C, of 2 mfds. and two No. A-6-116 telephone in-

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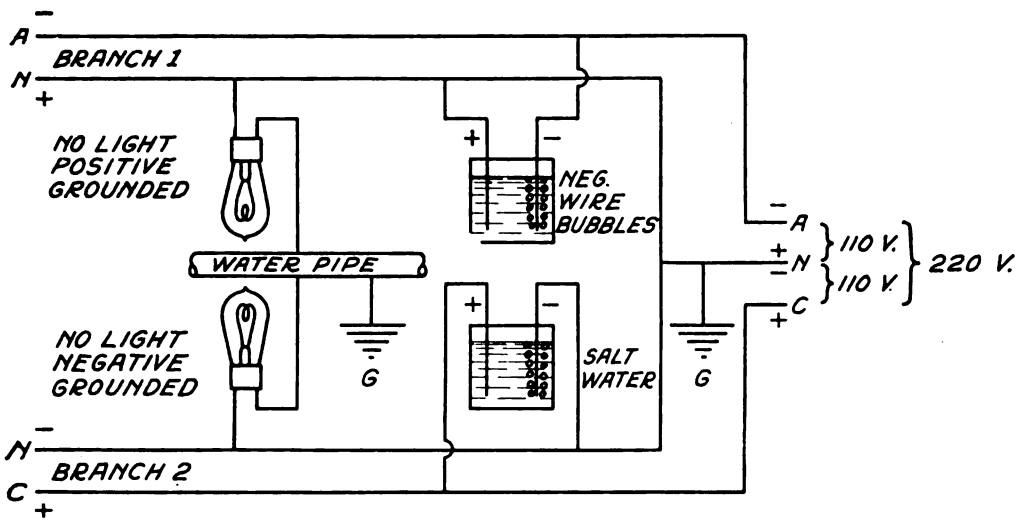

HOW TO DETERMINE THE PROPER SIDE OF THE LIGHTING LINE THAT YOU WANT TO USE

FIGURE 4: *The article tells just what to do to make this test with the aid of the diagram.*

duction coils X, of the same manufacture. These coils are not used as induction coils, but as choke coils. Their individual primary and secondary windings are so connected with respect to each other that the reactance of each coil is a maximum. This is accomplished by connecting the windings of a coil in series so that the magnetic fields established by the flow of current through them will aid each other.

The method of connecting the coils may be better understood by the novice perhaps, by referring to the numbers of the coil terminals. The primary terminals are numbered 3 and 4, while those of the secondary are designated as 1 and 2. Terminals 2 and 3 of each coil are connected together, and another connection is made from terminal 1 of one coil to terminal 1 of the other. The No. 4 terminals of both coils are wired to the condenser and the switch S1, as indicated in Figure 2.

It will be observed that the condenser and coils are connected in series with the line, through the switch, and that the amplifier "B" terminals are wired to those of the condenser. Arranging the condenser in shunt to the line, with respect to the amplifier plate circuit, restricts the path taken by amplified signal currents in the latter to its immediate limits. This results in efficient amplification. It should be emphasized that the condenser does not serve merely as a bypass condenser, but is an important part of the filter as well.

How the Charging Circuit Works

For charging the storage battery, the resistances R1, R2 and R3 are used. The first and second of these are shown in the upper right-hand corner of Figure 2, and have a resistance of approximately 22 ohms each. They are 550-watt, 110-volt heating elements such as are seen in the popular portable copper reflector heaters for sale in electrical shops, etc. One of these elements will pass a current of about 5 amperes at the rated voltage. As the storage battery used by the writer for lighting the tube filaments of his receiver was of low ampere-hour capacity and had a normal charging rate of 4 amperes, the two heating elements were connected in series for charging. This permitted the battery to be charged at a rate of about 2.5 amperes, which is preferable to employing a rate in excess of the normal one.

For the purpose of replacing the current lost from the battery through surface leakage and other causes, a trickle charging circuit embracing the resistance R3, was found useful. The resistance took the form of a reading lamp of 60-watt size and had a resistance of about 200 ohms. By manipulation of the single-pole double-throw switch S4, the lamp could be operated either directly from the line, or indirectly through the battery. When connected in the latter manner, the battery charged slowly at a rate close to 0.5 ampere. When it was desired to charge the battery at the high rate, the single-pole single-throw switch S3 was closed. The battery connects to the panel at the terminals indicated. Current is supplied to the tube filaments of the set by closing the double-pole single-throw switch S2.

In the event that charging rates of 5 or 7 amperes are required for a battery, the necessary current may be obtained by substituting a third 500-watt heating element for the 60-watt incandescent lamp used as R3. To charge a battery at 5 amperes, the switch S4 is thrown to the down position, while switch S3 is left open. The 7-ampere rate is obtained by clos-

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ing switch S3 in addition to switch S4. Throwing switch S4 to the up position places resistance R3 directly across the line. Obviously, this position of the switch should be used only when R3 is a lamp employed for illuminating as well as for trickle charging.

It may be of interest to the reader to learn that the tube filaments may be operated while the battery is on charge. When this convenience is made use of, however, the battery-charging rate is reduced to the extent of the current drawn by the tube filaments, and the battery will, therefore, require a greater time to be restored. The leads to the battery should not be removed under any consideration while it is being charged in the above manner, as this would cause the tube filaments to be burned out instantly due to the high charging voltage which would be impressed directly upon them.

How to Connect the Filter and Panel to the Receiver Circuit

In connecting the filter and charging panel to a receiver circuit, as illustrated in Figure 3, certain precautions should be observed.

First of all, the fuses inserted in the fuse block on the panels should be of sufficiently low current-carrying capacity to fully protect the house fuses and the circuits of the receiver against the effects of a possible short circuit. At the same time, they should be heavy enough to pass adequate current for charging the storage battery. It will be found that 10-ampere fuses will fulfill both these requirements.

Another point of prime importance is that in all cases where the filament or amplifier plate circuits of a receiver equipped with this panel are conductively associated with the earth or ground connection, as in Figure 3, the antenna tuning condenser *be placed in the ground lead* below these circuits, as shown. Either this or a 1-mfd. paper condenser should be inserted in the ground lead. One side or the other of the D.C. line connected with the panel, is grounded by the power company. This may cause the enthusiast considerable trouble unless he is on his guard.

The connection L, Figure 3, need not be made, as the negative terminal of the amplifier "B" source on the panel is also made through the internal circuits of the latter with the negative terminal of the "A" or filament battery. An inspection of Figure 2 will make this clear. It is highly necessary that the negative sides of both the "A" and amplifier "B" sources be connected together to avoid short circuiting the battery, which would result were their "B" minus and "A" plus terminals to be joined, as is the usual practice. Connecting the sources in the prescribed way does not noticeably decrease the amplification of signals as against that obtained with their more usual relation. In connecting the filter and charging panel to a receiver, the internal battery connections of the latter should be altered to meet the necessary requirements. That is, provision should be made for inserting a "B" battery in the detector-tube plate circuit, and for connecting the amplifier "B" terminals independently to those of the panel. In the event that a connection exists between the "B" minus and "A" plus terminals of the amplifier, this should be removed and the proper connection made.

The Edison three-wire lighting and power system is installed in most homes equipped with direct current. One of these wires is grounded and this is called the neutral wire, which has been designated as N in Figure 4. The remaining wires are negative and positive with respect to the neutral wire and have been indicated as A and C, respectively, for convenience. By means of suitable connections to the wires of the system, the voltages indicated are obtained. Branch 1 consists of wires A and N, while branch 2 comprises wires N and C. The radio fan may determine which of these branches is at his disposal by means of two simple electrical methods.

The positive and negative sides of the line are first ascertained by an application of the salt-water test referred to in the beginning of this article.

For determining which of the leads of the system is grounded, a lamp socket, a 110-volt incandescent lamp, and a piece of insulated wire long enough to reach from the attachment plug to the nearest water pipe, will be required. Having made one of the attachment-plug wires, say the positive, fast to one of the socket terminals, and connected the remaining socket terminal to the water pipe through the piece of wire just mentioned, the lamp is inserted in the socket. If the lamp lights, the negative side of the line is grounded, indicating branch 2. This may be verified by connecting the negative lead from the attachment plug to the socket. Failure of the lamp to light in this instance indicates the negative side of the line to be grounded. Opposite results of the above ground tests will indicate the positive side of the line to be earthed, in which case the enthusiast will be on branch 1 of his lighting system. When using an attachment plug of the plug-in type, the smaller member of which is separable from the larger and is equipped with two prongs which engage the latter, care should be taken not to reverse the insertion of these prongs in the screw part of the plug during tests, or after the line has been connected to the panel.

A list of the materials required for the construction of the filter and charging panel is given at the head of this article. The wooden panel is first covered with asbestos paper to protect it from the effects of an accidental short circuit and the heat of the charging resistances. A neat way to do this is to tack the 1-inch margin of the paper down around the edges of the panel. The various units are then mounted in their relative positions, as suggested in Fig. 1, and are wired in accordance with the panel wiring diagram, Fig. 2. Consistent arrangement of the panel terminals with regard to their polarities will facilitate the installation of the unit later. When the panel has been completed, all circuits should be traced for accuracy before it is connected to the line and the receiver.

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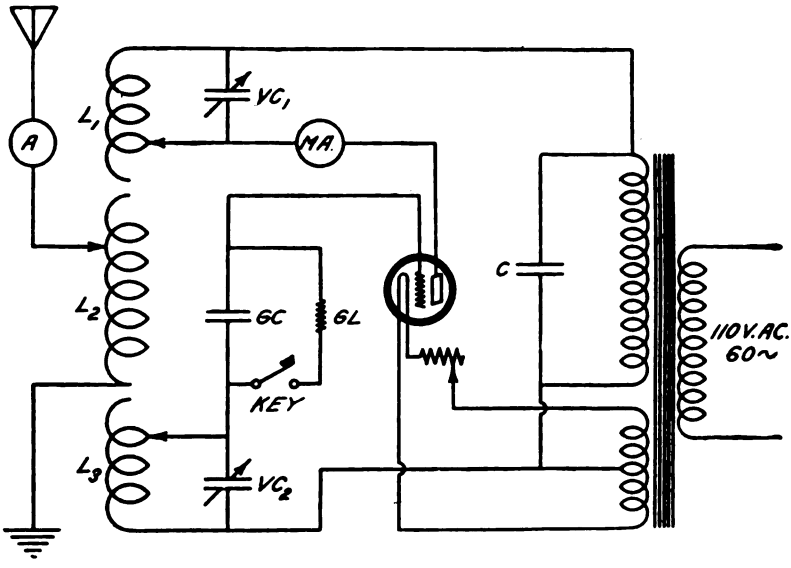

MODIFIED MEISNER CIRCUIT WITH A.C. POWER SUPPLY

Cost of parts: Not more than $40.00. (Note: The costs of tubes and batteries are considered "extras" and are not included in the costs given in these descriptions.)

Emitted wave: Fairly broad. Using straight A.C. on the plate of the oscillator tube causes a 30-cycle note to be transmitted (as the modulator frequency) which spreads out the frequency to a band instead of a single, pure wave. This will cause interference in nearby receivers which do not tune sharply.

Operation: Easy to get working and inexpensive to keep up. The first cost is the last cost except for tube replacements. It will work on any type of antenna.

Construction: Nothing difficult about making this set, probably as simple as a single-tube receiving set.*

Approximate transmitting range: 500 miles.

Outstanding features: Simple to make and get into operation. Set functions without any moving parts to wear out, is applicable to a large band of wavelengths with any type of antenna, and requires no batteries. It may cause interference to nearby broadcast listeners, however, if they use single-circuit tuners or other simple sets that are deficient in tuning qualities for reception.

*(See POPULAR RADIO, *April, 1923, page 312, for constructional details.)*

100 BEST HOOK-UPS

INSTALLMENT NO. 6

Transmitting Sets for Amateurs

The preceding installments of this series of hook-ups gave our readers a condensed review of receiving *circuits, ranging from the most simple and inexpensive of crystal sets to some of the most highly developed sets for long-distance work. This present installment gives the novice a little survey of amateur* sending *sets, ranging in cost from $15.00 to $175.00 and with a transmitting range of anywhere from 5 miles to 2,500 miles. And the real joy of radio—as any "radio ham" will tell you—begins when the listener turns his hand to sending!*

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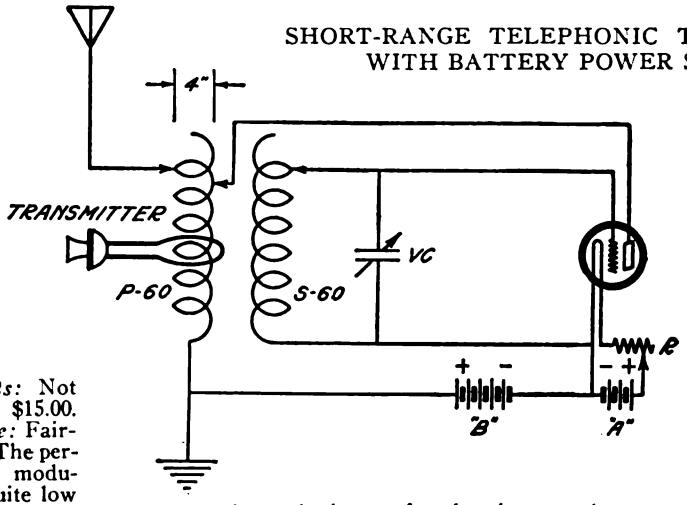
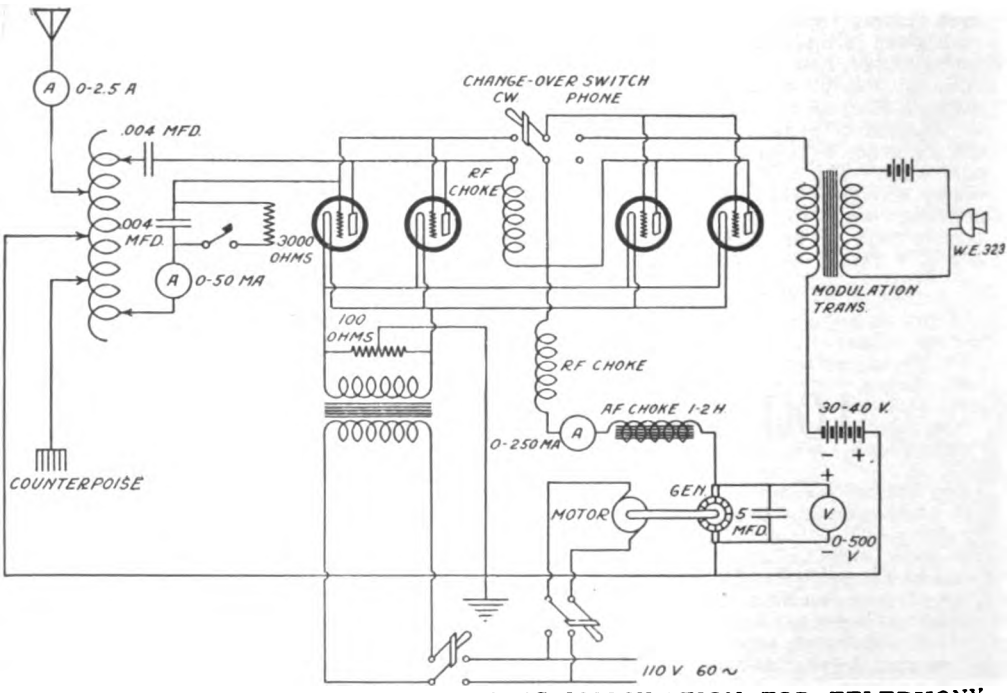
SHORT-RANGE TELEPHONIC TRANSMITTER WITH BATTERY POWER SUPPLY



Cost of parts: Not more than $15.00.
Emitted wave: Fairly sharp. The percentage of modulation is quite low and the wave does not spread much in frequency.
Operation: Just as simple as a single-circuit receiving set. The UV-201-A tube may be used with about 100 volts of "B" battery for the plate supply.
Construction: Simplicity itself.*
Approximate transmitting range: 5 miles.
Outstanding features: Simple to make and operate.

(See POPULAR RADIO, April, 1923, page 309, for constructional details.)



THE HARTLEY CIRCUIT USING HEISING MODULATION FOR TELEPHONY

Cost of parts: Not more than $175.00.
Emitted wave: Extremely sharp for CW and good on telephony.
Operation: Complicated. A thorough understanding of the principles of modulation is necessary to get the set operating efficiently on telephony.
Construction: Difficult.*
Approximate range: 2,500 miles (on CW), and 1,000 miles (on telephony).
Outstanding features: This circuit is noted for its efficiency and perfection of modulation. This type of modulation is used at most of the broadcasting stations.

(See POPULAR RADIO, December, 1922, page 256, for constructional details.)

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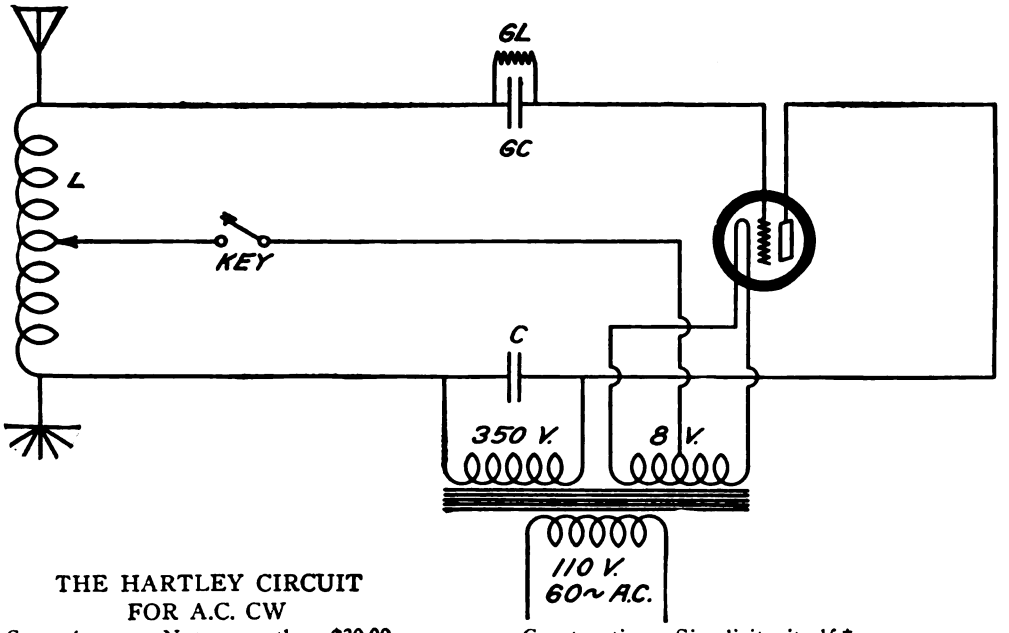
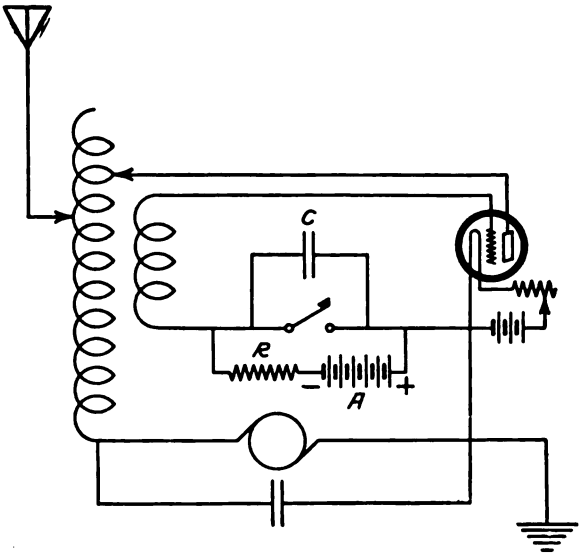


THE HARTLEY CIRCUIT
FOR A.C. CW

Cost of parts: Not more than $30.00.
Emitted wave: Fairly broad.
Operation: Easy to get working and very inexpensive. It will work on any type of antenna. A counterpoise is advisable.
Construction: Simplicity itself.*
Approximate range: 500 miles.
Outstanding features: Simple to make and easy to get into operation. It is also most economical to set up.

*(See POPULAR RADIO, *December, 1923, page 513, for constructional details.)*



GRID-TICKLER CIRCUIT FOR PURE CW TELEPHONY

Cost of parts: Not more than $125.00.
Emitted wave: Extremely sharp.
Operation: Not difficult.
Construction: Nothing especially complicated in the arrangement of this set, but the builder should have had some experience in putting together receiving sets, wiring, soldering and the like before he attempts to make a transmitter.*
Approximate range: 1,000 miles.
Outstanding features: A sharp wave, and a pure "whistle" note for telephony.

*(See POPULAR RADIO, *September, 1922, page 39, for constructional details.)*

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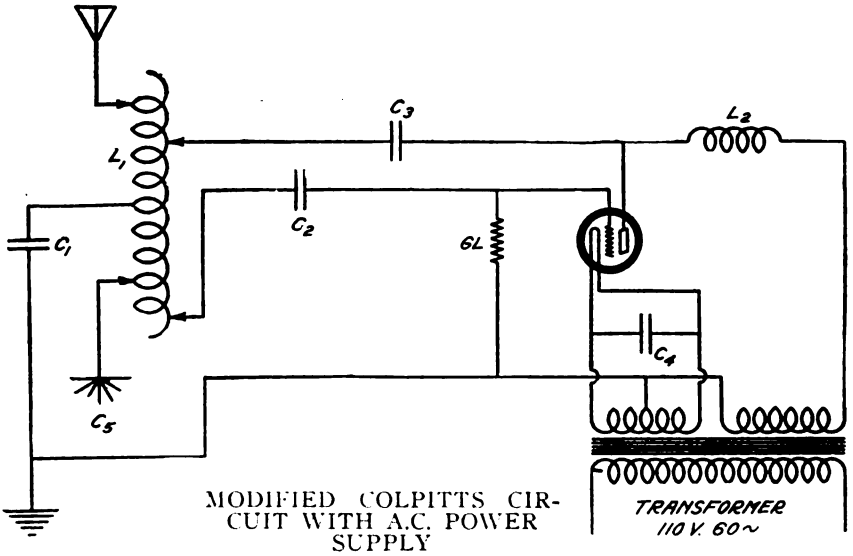
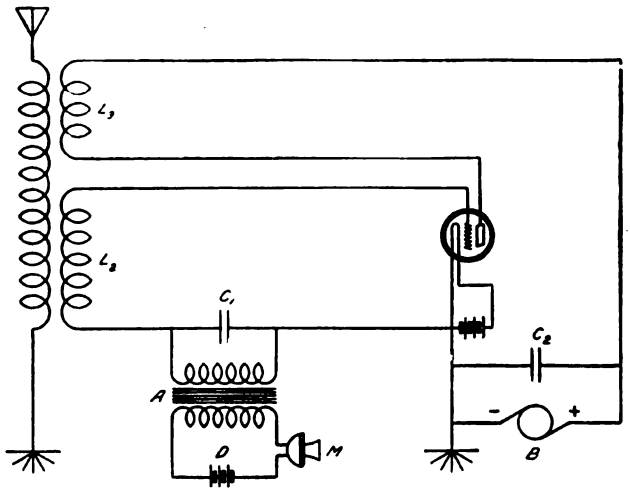


MODIFIED COLPITTS CIRCUIT WITH A.C. POWER SUPPLY

Cost of parts: Not more than $35.00.
Emitted wave: Fairly broad. (This is due to the A.C. power supply and not to the type of circuit used.)
Operation: Simple to get into successful operation (if a counterpoise is used).
Construction: Not complicated.*
Approximate range: 500 miles.
Outstanding features: A persistent oscillator and efficient. This set employs no batteries of any kind. It is run wholly from the 110-volt, 60-cycle, A.C. lighting mains.

*(See POPULAR RADIO, *September, 1923, page 249, for constructional details.)*



THE MEISSNER CIRCUIT FOR TELEPHONY, WITH GRID MODULATION

Cost of parts: Not more than $120.00.
Emitted wave: Fairly sharp.
Operation: It is quite difficult to get a large percentage of modulation and still keep the transmitted speech clear.
Construction: The most important parts in this circuit are the coils; they should be wound on high-grade composition tubing with no shellac on the windings. A regular modulation transformer should be used at A.*
Approximate range: 50 to 100 miles (on telephony.
Outstanding features: This is a good single-tube telephone outfit for the amateur. It will give him a lot of information and allow him to try a lot of experimenting to get better modulation.

*(See POPULAR RADIO, *July, 1923, page 42, for constructional details.)*

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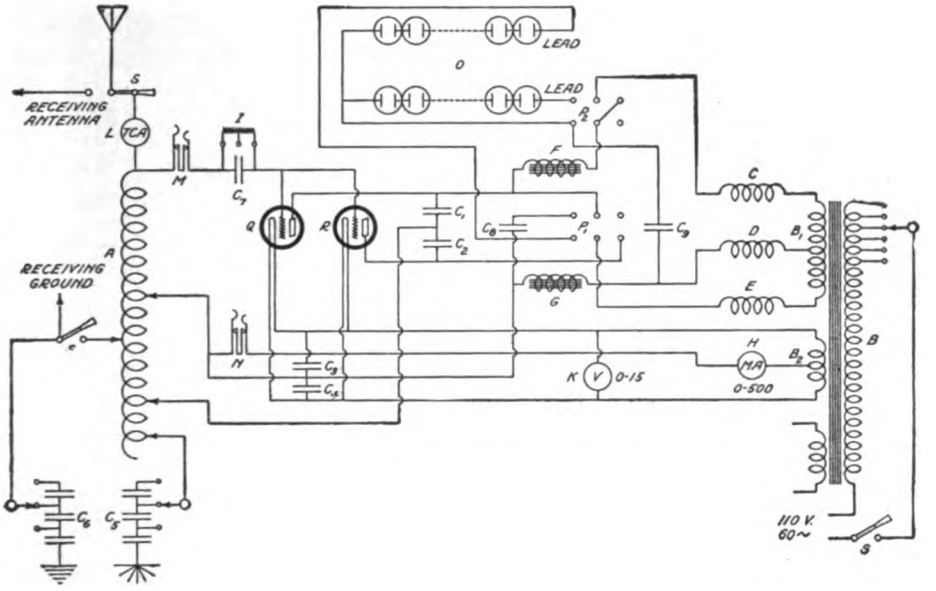
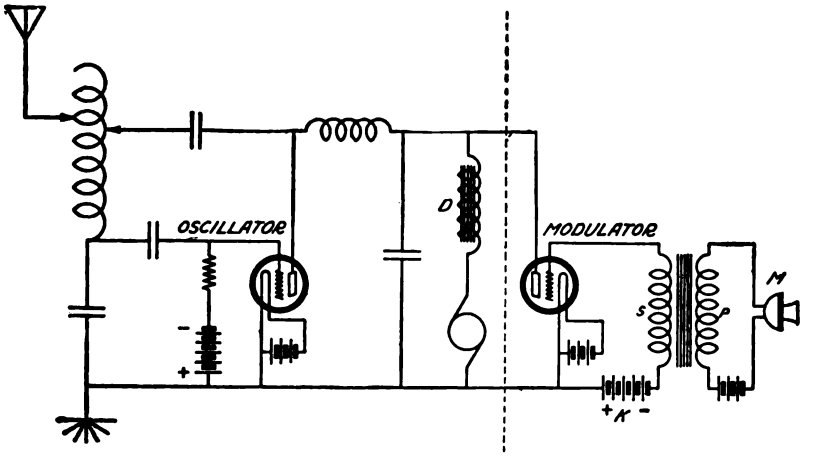


A COMBINATION HARTLEY CIRCUIT FOR USING A CHEMICAL RECTIFIER FOR RECTIFYING THE PLATE CURRENT, OR FOR USING STRAIGHT A.C. ON THE PLATES OF THE TUBES

Cost of parts: Not more than $125.00 (for use with 50-watt tubes).
Emitted wave: Broad (with self-rectified A.C.). Somewhat sharper (with chemically-rectified A. C. It depends upon how good the filter is).
Operation: Complicated.
Construction: None but the experienced amateur had better try to build this set alone.*
Approximate range: 2,500 to 3,000 miles (on telephony).
Outstanding feature: A powerful set which can be used without batteries for CW telegraphy.

*(See POPULAR RADIO, *April, 1923, page 298, for constructional details.)*



THE COLPITTS CIRCUIT WITH HEISING MODULATION

Cost of parts: Not more than $130.00.
Emitted wave: Fairly sharp. The modulation is (if the set is properly adjusted) of a very high order and also of a high percentage. This may cause the wave to be broadened out so that the set may interfere locally.
Operation: Simple and efficient.
Construction: Rather complicated.*
Approximate range: 500 to 1,000 miles (on telephony).
Outstanding features: The best modulating system and the one most used for broadcasting.

*(See POPULAR RADIO, *July, 1923, page 46, for constructional details.)*

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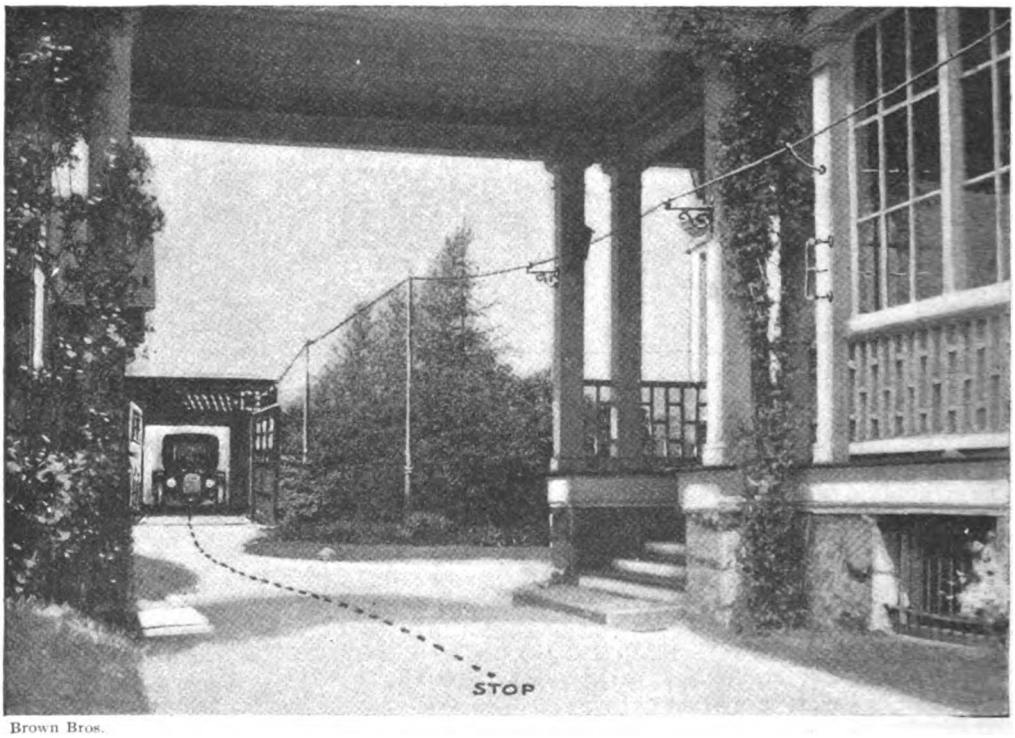

Brown Bros.

A RADIO CHAUFFEUR THAT BRINGS YOUR AUTO TO THE DOOR

The conductor strung between the house and the garage serves as a path for the radio waves that automatically start the car and open the doors. Other waves in this same conductor guide the driverless car up to the step, where the smaller conductor, fixed to the doorpost, stops it.

Will Radio Do Our Housework?

Only forty years ago the layman laughed at the possibility that electricity could be used for even so simple a task as lighting our homes. Yet since then electricity has developed into an indispensable domestic servant. That radio may demonstrate even more startling possibilities in the home is pointed out in this article—which is written by a well-known scientist under the *nom de plume* of—

THOMAS ELWAY

IF you should fall asleep some day, like the heroes in the fairy stories, and not wake up for a hundred years or even for fifty years, you would wake into a very different world from that which we enjoy today.

Just what kind of a world you would find might be, of course, a matter of opinion. But there is one thing about it of which we can be quite sure: it will be a radio world, a world in which the ether waves will play an astoundingly larger part than they do in the world of today.

Remember the changes in every condition of life that have been accomplished in less than a century by the discovery of how to use electricity. The ether waves that we know about now are incomparably more powerful and pervasive than mere electricity led around in wires. And as these marvel-

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ous waves come more and more into daily use we may expect them to work an even greater revolution in almost every feature of our daily life.

Your radio house of 1975 or 2024 will be a very different kind of place from your house of today. It will have few servants or none—for all the disagreeable tasks of housekeeping will be done by radio or by machinery that radio controls. Communication from room to room or between different houses will be as much more convenient than it is today as our present telephone devices are better than the bell-cords and speaking tubes of even forty years ago.

When you want your automobile (if, indeed, they still use automobiles in 1975) it will come from its garage all by itself and will stand waiting in front of the door. Radio will bring it. Your bath will be drawn and warmed, and perhaps electrified, for you by radio. Your breakfast egg will be cooked by radio, your beefsteak will be kept warm for you while you eat, your coffee will be percolated in just the way you like it, all by these wonder-working ether waves that we are just beginning to understand and put to work.

Do these things seem too marvelous? They are not. Everything that is predicted in these paragraphs *could be done now* if anybody wanted to spend the money to do it. Within five years many of these things will have been done. The development of the radio house of the future will be well on its way.

The future of radio entertainment, for example, is already visible. The linkage of the broadcasting stations to each other has been accomplished by land wires in a dozen instances and by radio-relay systems in at least three, including one that spanned the Atlantic. This means that within a year or two the entire country will be listening to the speeches of the President in Washington, to the Metropolitan Opera in New York or to the Hawaiian entertainers in Honolulu. Great music, inspiring addresses, successful plays will be no longer the exclusive property of those who live in large cities. The smallest hamlet will listen to the greatest of the symphony orchestras or go to school under famous professors.

Nor will this wide availability of entertainment and of opportunity for self culture be confined merely to sounds. It is safe to say that within a year or two the broadcasting of scenes as well as sounds will be done experimentally. Most of us that are now alive will live to see it as common as the present broadcasting of music and speech. The apparatus for this has already been invented.* It is not perfect yet, but neither were the telephone or the moving picture perfect in the first years after their invention. We will see before we die the radio play, visible as well as audible in our own homes, as common as the present day phonograph or motion picture or radio concert.

There is a sure promise, too, of what we might call "canned radio." Perhaps a special event like the President's speech or a recital by some great artist, occurs at an hour when it is impossible or inconvenient for you to be listening. Must you therefore miss it? Not in the least. There is already in existence more than one form of apparatus that can be attached to a radio receiver and that will record for you anything that comes in during the hours for which you set it. You can leave home in the morning, having adjusted your set for the programs that you want to receive, and come back at night to find the record all made for you. Play off the concert, listen to the President's words at your leisure, and, if you feel like it, listen to this over and over again. Store the record away. Let your great-grandchildren listen to it, too, if they want to.

* See the article, "The New Radio Movies," in POPULAR RADIO for December, 1923.

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Brown Bros.

HOW RADIO CAN COOK YOUR BREAKAST

A coil of wire supplied with high-frequency current surrounds the egg cup; radio waves from this coil penetrate the egg and cook it. Meanwhile other coils serve as sources of radio waves to cook the chops inside the covered dish and to keep warm the coffee pot and the food on the plate. All this, is a present-day possibility.

All this is possible now. Indeed it is being done every day in at least one experimental laboratory. It belongs, really, to the possible radio house of the present, not that of 1975.

Equally possible, though less successfully done at present are the marvels of radio control. The little toy called "Radio Rex" is familiar to everybody. The toy dog that comes out of his little kennel when you speak to him does not really work by radio, but he does exemplify a prophecy of radio. Anyone who feels like it can build into his house, tomorrow, a radio device, for example, that will open a door if you speak to it. Set this device for the words "open sesame" and you can emulate the master of the forty thieves. Speak these words to the door as you approach and it will swing open, to close after you as you pass through. Any competent radio engineer can build such a device for you. It might cost two or three hundred dollars, but what did the first telephone cost? Before long we will be buying radio door openers like this perhaps for ten or twenty dollars, possibly for two or three.

And about the automobile. Anyone can equip his garage and his automobile with radio devices so that a set phrase such as "automobile come out" spoken at some fixed place in the house will start off a train of automatic operations and bring the automobile, unoccupied by any human operator, to the door.

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How to do this? It is very simple. The spoken words actuate a radio transmitter fixed to respond only to these words, that is, to a special succession of sounds. This transmitter sends out waves that operate a radio relay under the hood of the automobile. This relay starts the engine of the car. When the engine has reached a proper speed a small transmitter under the hood sends out another special signal that operates a relay on the garage door so that the doors swing open. The act of swinging open starts a third transmitter and this gives to the relay in the car the signal that meshes the gears and starts the car in motion. As soon as the car has left the garage door it comes under the direction of a radio wave from a suspended wire along the driveway and this wave, acting through the radio relay system under the hood, steers the car up to the door and stops it at the step. You can even equip the car with an automatic anti-collision device that will stop it instantly if any visible obstacles, such as another car or a playing child, happens to be in the road in front of it.

All this, mind you, *we could do now.* Any time that you want a radio garage you can have one by hiring a good radio engineer or by becoming, yourself, an expert in radio control. The sequence of automatic operations that I have described for the automobile is far less complicated and difficult than the operations necessary to steer an unoccupied battleship or airplane. Both of these tasks have been accomplished with entire success.

But to get back to the house. The calling of the automobile is by no means the chief duty performable by radio control. Much of the house service, like stoking the furnace or carrying out the ashes, can be done in the same way. There need never be any winding or setting of clocks, for all kinds of time-keeping devices will soon be automatic, actuated by the time signals sent out from the great broadcasting stations. Even a pocket watch that thus regulates itself is possible and at least one such has been built.

Table service may be similarly automatic. When the soup is finished you say merely "bring in the fish," and the fish comes in from the kitchen by himself; slides in perhaps on some sort of track or runway, or rolls in on a little automatic cart like a tea wagon.

But perhaps, in fact, there will be no such thing as table service. It may not be necessary at all for it may be replaced by applications of radio heat.

Radio heat is not really heat; it is a way of making heat exactly when and where you want it. There is a familiar experiment that illustrates what radio heat is. Inside a wooden box of some kind you put a coil of insulated wire with the turns of the coil horizontal. On top of the box you place an ordinary iron stove-plate. Then you pass a powerful high-frequency current through the coil of wire. The plate gets hot. You can easily fry an egg on it. Indeed, if you have power enough in your high-frequency coil the plate may get red hot or even melt.

This experiment is always astonishing to the uninitiated. The wooden box hides the high-frequency coil. The plate, quite obviously, is not connected with any electric wires or anything else. Where does the heat come from?

It comes, of course, by radio. The ether waves going out from the coil enter the iron plate and make eddying currents of electricity in the iron. These currents heat the plate.

It is possible to heat anything in this way, even non-conducting things like glass or rubber. The only difference is that you need more power. With enough power and with other arrangements that are quite possible in theory you could have, for example, an egg-cup that would cook your egg just to the right point if you merely place the egg in the cup.

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Brown Bros.

A MODERN "OPEN SESAME"

A radio device can be arranged to open doors on the signal of a spoken word. The microphone and other radio apparatus in the box over the door are adjusted to operate an opener built like an ordinary door check.

Suppose you have a table equipped with these devices and you sit down to breakfast. From a little cooler at one side you lift out the orange juice (which has been prepared a few minutes before by an automatic squeezer) and an egg. You place the egg, unbroken, in a little hollow on the radio egg-cooker. Before you have finished the orange juice the egg is cooked. Meanwhile you have selected, we will say, a lamb chop. You have laid the chop on a plate and set the plate on a certain spot on the table. Radio waves from underneath cook the chop. Other radio waves, slightly less intense, keep it warm for you while you eat.

This sounds like the marvels of a motion-picture comedy but it is not. We can do it all now except for one thing. It is difficult to keep these heat-producing radio waves in their place. Sometimes they spread too widely and melt a soup spoon or set fire to the sugar in the sugar bowl. Before we can really have radio breakfasts that are both safe and comfortable we must learn better how to control these unusually powerful waves. That we will learn how to do this no one doubts. Radio breakfasts, and dinners and suppers, too, and midnight welsh rarebits, are coming just as surely as are the "canning" of radio programs and the radio movies.

Radio heat will help us, too, in the matter of hot water. It seems startling to remember, nowadays, that running hot water in houses, even those of the very rich, is an astonishingly recent invention. Thirty years ago automatic hot water was a marvel that people went miles to see as they now go to see the new navy airship or the talking movies.

We can improve it still more. A radio device fitted to the bathtub or to the faucet will give you, instantly, hot water of any temperature that you want and will save one-half the piping in the house to say nothing of a lot of fuel.

We might go on to think of radio hot-water bottles, of radio milk-warmers for the baby, of radio warmers for the baby itself on cold nights. There are thousands of probable applications for radio heat. But there is another possible development of radio that promises, to me at least, a still greater boon than easy heating.

This is the elimination of noise. The curse of civilization is its clatter. Nobody knows how much the noise of cities costs the people who have to live in them in shattered nerves and ruined health. It is no mere accident that

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"peace and quiet" are linked together so often in common speech.

Of course, a lot of the city noise is inevitable. Automobile engines are bound to make some noise, though this lessens from year to year. Rapid transit must make some noise, though not a fraction of what it inflicts on us now. Even the feet of people on the pavement cannot be kept absolutely silent.

But there is one great element of noise that we probably can avoid, an element that radio may help us to elminate. This is the noise of warning signals; the bell of the street-car, the shrill call of the telephone, the whistle of the traffic policeman, the automobile driver who thinks that his horn is something on which to play a tune.

How can these be displaced? No one can be sure. But here is an idea. It is an idea of replacing sound-signals with touch-signals. If you want to attract the attention of a man in front of you in church you do not shout at him, you touch him on the shoulder. Nobody is disturbed except the man who must be disturbed.

Can we do this generally? Possibly. There is one way in which it might be done by radio. It is comparatively easy to make a small radio device that you can carry in your pocket and that will attract your attention by a slight touch or tingle whenever it is operated by a received radio wave. Perhaps automobile drivers could be required to wear such devices and traffic policemen could be equipped with transmitters to actuate them instead of with whistles. Perhaps some similar device will replace the door-bell and the telephone bell.

Such things are farther ahead, I imagine, than the useful household applications of radio control and of radio heat. But in fifty years a lot can happen. The radio house of 1975 may be not only soundless but still more marvelous in a hundred ways that we cannot even guess.

Underwood & Underwood

BROADCASTING SIDE-LINE REPORTS OF A RUGBY GAME

French sport writers are stealing a leaf from the American book of journalistic practice; here is a picture made in the Pershing Stadium in Paris during the France-Scotland rubgy contest.

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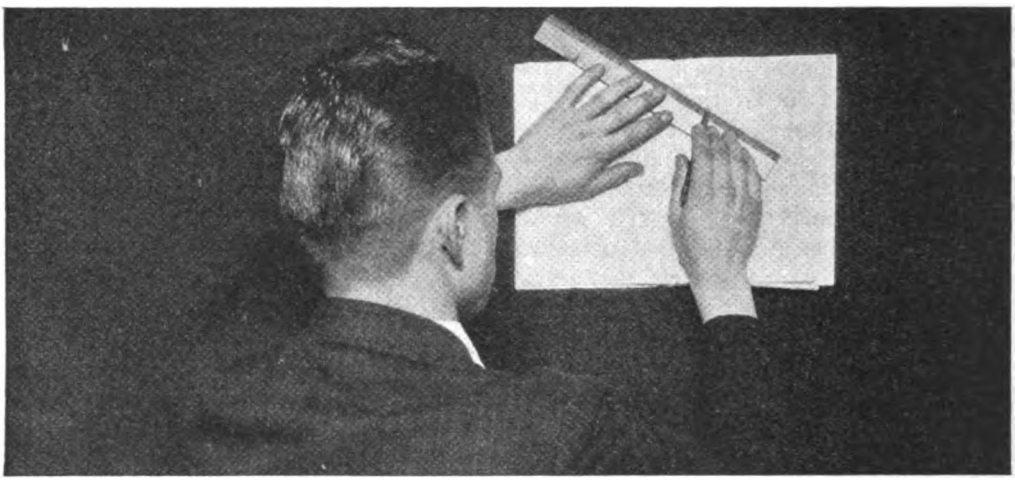

From a photograph made for POPULAR RADIO

¶ *Lay your ruler across the alignment chart, as described in this article—and read off at a glance the answer to your problems in calculations.*

A MEASUREMENT CHART

FOR DETERMINING THE MAXIMUM CAPACITY OF A VARIABLE CONDENSER

ARTICLE NO. 7

By RAOUL J. HOFFMAN, A.M.E.

IN a previous article we have given the calculation of a fixed condenser which follows the equation:

$$C = .0000002248\ A\ K/d$$

where C is the capacity in microfarads, A the area of the effective plates in square inches, D the distance between the plates and K the dielectric constant, which in our case—for air—will be 1.

The area of the plates will be very closely figured by taking the area of one rotor plate and multiplying by the number of the plates *less one*, as the capacity effect is accomplished *between* adjacent plates. From an economical standpoint mostly, an odd number of plates is used.

The thickness of the plates is measured with a sheet-metal gauge, the space between the plates may be measured by using various thicknesses of blank wire; the heaviest wire which could be placed between the plates will be taken as to be equal to the distance between the plates.

Another close method could be used with simplicity to measure the distance between plates by cutting small strips from the middle page of this magazine and placing them between the plates, multiplying the maximum number thus obtained by .003" (which is the thickness of the paper), resulting in the distance in inches.

Knowing the distance between the plates and the diameter of the rotor will be sufficient to calculate the maximum capacity of the condenser with the aid of the accompanying chart.

For example: a condenser has a rotor diameter of 2½ inches, 21 plates and a distance of No. 18 gauge wire between the plates. Connect 2½ on scale No. 1 with 21 on scale No. 2, intersecting at the reference line; then connect the intersection with 14 on scale No. 3 and read the maximum capacity of .00017 microfarads on scale No. 4.

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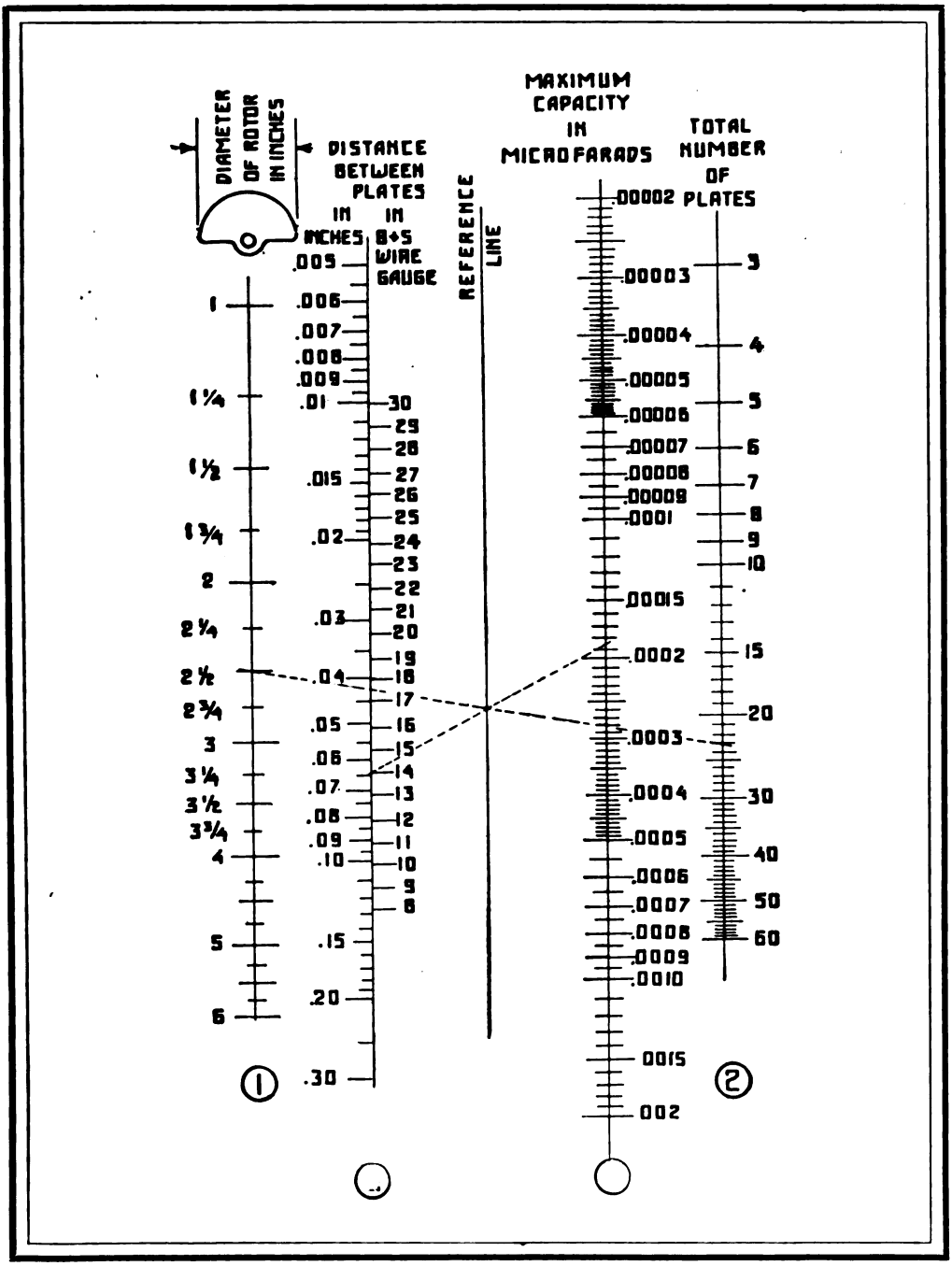

THIS CHART WILL HELP SOLVE YOUR CONDENSER PROBLEMS

This diagrammatic drawing will give you, at a moment's notice, the maximum capacity of any make of variable condenser, whether it contains 11, 17, 23, 26, or 43 plates. It does not matter whether the condenser has a spacing between plates of anywhere between .005 to .3 inch, the chart will tell you the capacity. This is important in buying a new condenser for a given circuit where a given capacity is necessary. The article tells in detail how to use the chart.

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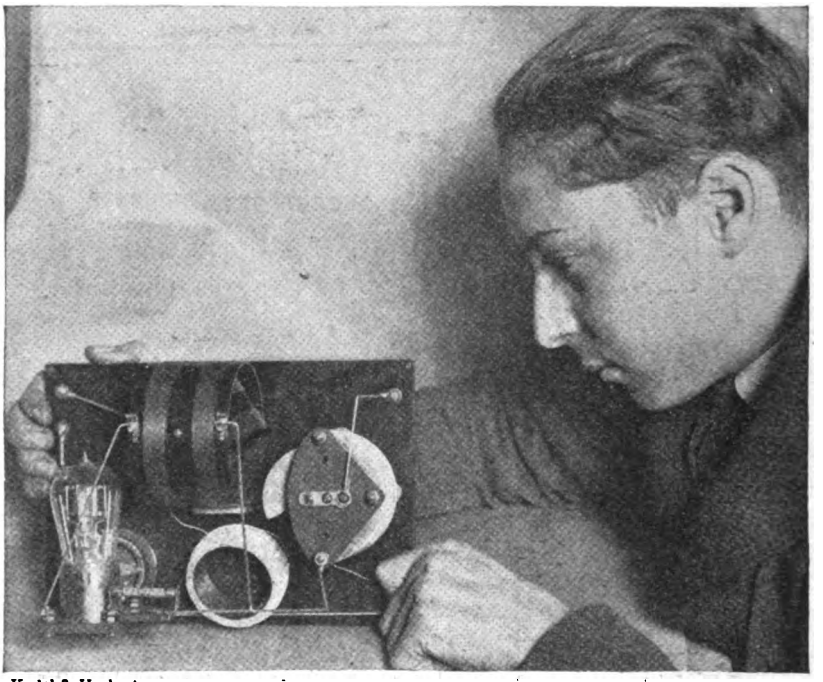

Kadel & Herbert

HERE IS THE TYPE OF SET THAT CAUSES ALL THE TROUBLE

FIGURE 1: *It is the improper use of the kind of set shown above that makes all the squeaks, whistles and howling, known as "re-radiation," that disturbs you and your neighbors.*

How NOT to Tune the Single-circuit Receiver

By LAURENCE M. COCKADAY, R.E.

ALMOST all of the listeners to radio broadcasting are familiar with the single-circuit tuner. At least all listeners have either operated one of these sets or have *listened in while it is being operated.*

And this does not mean that we have to be at the owner's receiving station to listen to it, either!

In the hands of a novice this type of receiver becomes a fine transmitter. There is no use of going into the details again of how this occurs; we have all read of "re-radiation" and its interference, and we all have heard the whistling, shrieking noises that re-radiation produces. Nevertheless, re-radiation interference is becoming terrifically acute, especially in these days of listening-in with ultra-sensitive receivers for DX. A little single-circuit set operated within a mile or so of such a DX listener's station will play havoc with his reception. It is discouraging to be compelled to turn off your expensive receiver in disgust just because some neighbor is using his simple little set—but *using it incorrectly.*

There is no need for re-radiation—even if the single-circuit receiver is used.

Just turn to the four photographs that accompany this article. You will find out in these pictures how *not* to tune your single-circuit regenerative set.

This information will give *you* better results and it will eliminate the trouble you have always been causing your

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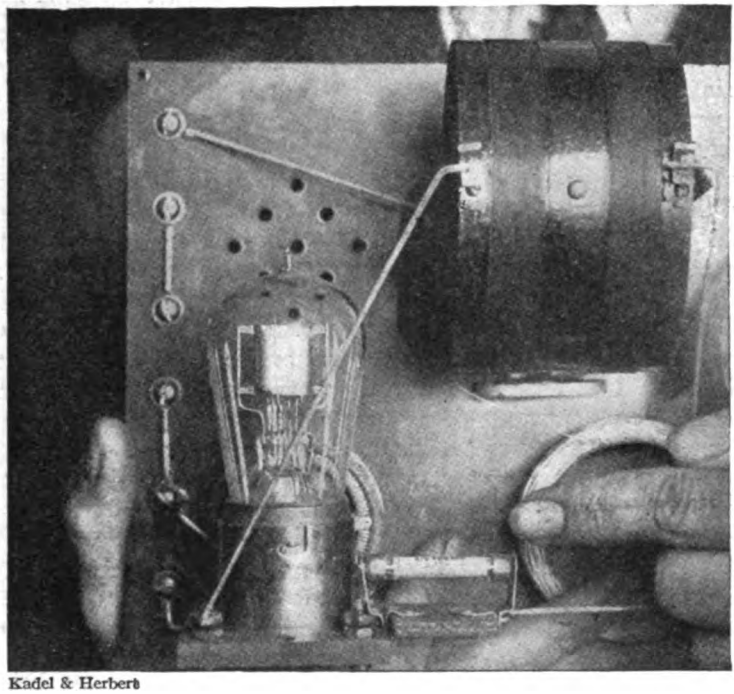

Kadel & Herbert

FIGURE 2: DON'T *use a grid-leak of too high a resistance; 2 megohms is plenty. And* DON'T *use a grid condenser of more than .00025 mfd. capacity.*

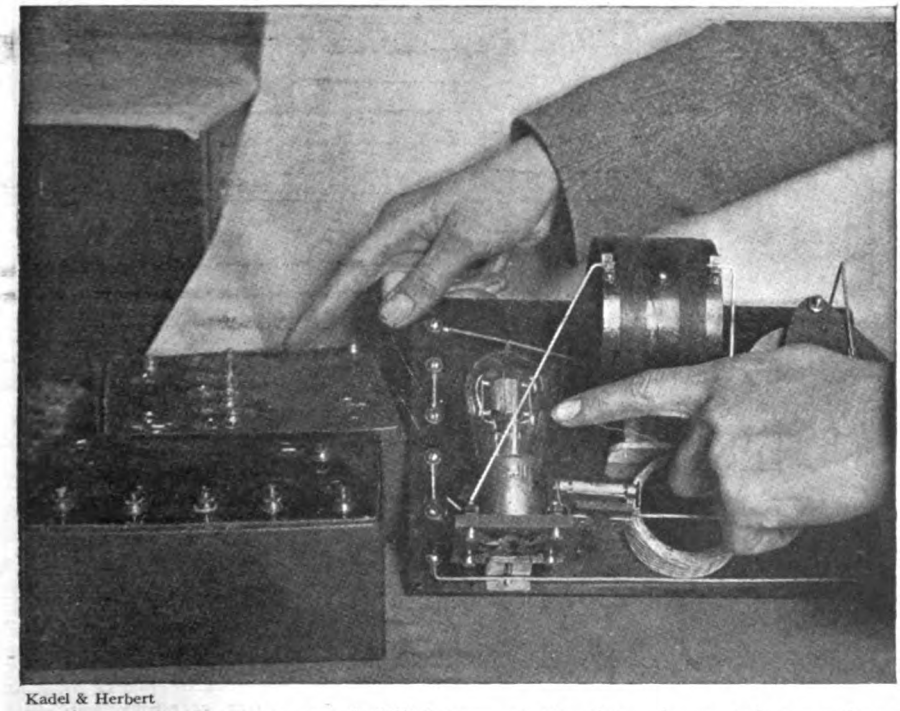

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FIGURE 3: DON'T *put too much "B" battery on the plate of your tube; a voltage of between 16½ and 18 volts is plenty for a soft tube. Higher plate voltages will tend to make the set oscillate too much and it will surely re-radiate.*

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neighbors in the way of whistling interference.

In Figure 1 we have a rear view of a regular single-circuit set with a variable condenser, a variocoupler, a honeycomb loading coil, a rheostat, a socket, a tube, a grid condenser and a grid-leak.

Be sure that you are *not* using too large a grid condenser. The capacity of this condenser should not be more than .00025 mfd. (See Figure 2.)

Be sure that you are *not* using too much plate voltage on your detector tube. This will also cause the set to have a tendency to oscillate too much. Use not more than 18 volts of "B" battery on the plate of the detector tube. (See Figure 3.)

Do *not* turn the knob on the variocoupler around too far when trying to pick up a station. If you do, you will hear a whistle when you pass over a station. Here lies the trouble, when *you* hear the whistle, *all your neighbors* hear it too, and it completely spoils their enjoyment.

Keep the tickler knob set only as high as necessary to bring in the signals *without* any suspicion of a whistle.

Do *not* turn up the filament rheostat too high. This will also cause the set to oscillate and produce the same disturbance in your neighbor's set as occurs when the tickler is turned around too far. (See Figure 4). Turn the filament up only far enough so that the signals come in clear without any whistling noises when you tune from one wavelength to another.

Just remember this; *don't* let your set whistle!

You would not whistle out loud at the opera or at the theater. Remember, that for radio the whole of space is the theater, and that you are not the only one in the audience!

Kadel & Herbert

FIGURE 4: DON'T *turn the tickler dial around to too high a number, and* DON'T *turn up the rheostat too high. These two points are the most important ones to remember if you wish to join in the movement for better reception with less interference.*

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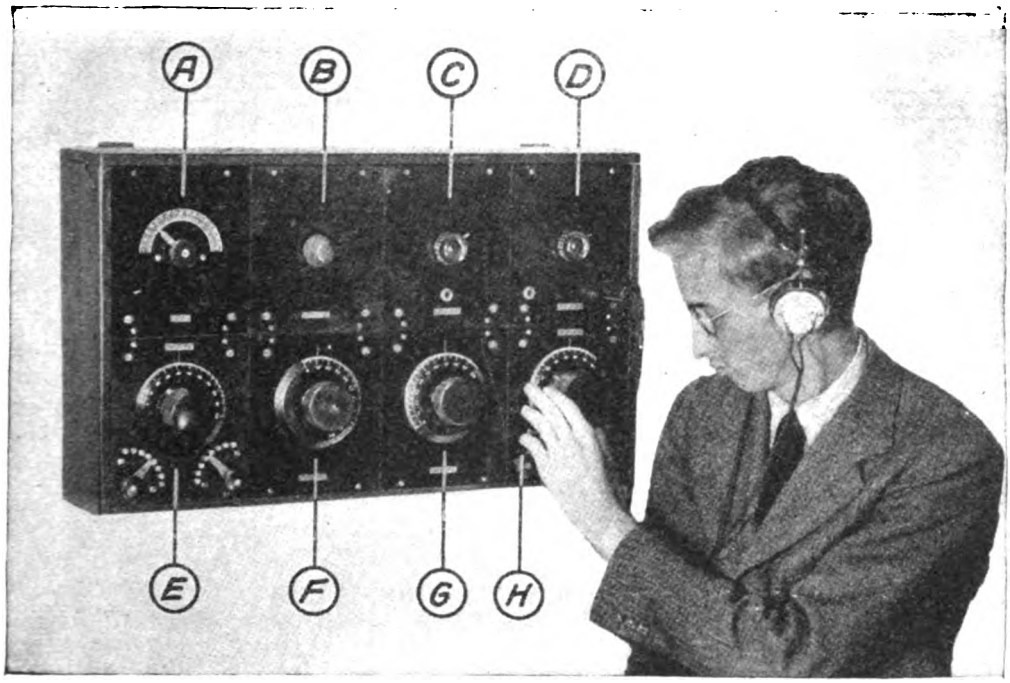

From a photograph made for POPULAR RADIO

THE UNITS OF THE SET

A is the variable condenser, .0005 mfd.; B is the detector unit; C and D are the amplifier units; E is the variometer and tapped inductor; F is the variable condenser and coil; G is the variometer and H is a variocoupler.

HOW TO BUILD

AN EXPERIMENTAL RADIO SET

By SPENCER BOYD

This article is written for the special benefit of the many fans who are more interested in actual experimental work—in trying out new hook-ups—than in merely listening in, and who enjoy comparing the results obtained on one circuit with the results from another circuit. This article tells how to make a set that will enable such fans to test out a number of circuits by merely rearranging the wiring.

COST OF PARTS: *About $65.00.*

HERE ARE THE ITEMS YOU WILL NEED—

1 Signal variable condenser, .0005 mfd.;
1 Fada vernier variable condenser, .0015 mfd.;
3 Chelsea vacuum-tube sockets;
1 CRL variable grid-leak;
2 Frost jacks, double-circuit;
1 Frost jack, single-circuit;
1 mica fixed condenser, .00025 mfd.;
2 Amrad basket-weave variometers;
1 Hilco variocoupler;
2 audio-frequency amplifying transformers;
1 UV-200 and 2 UV-201-a tubes; (or)
3 WD-12 tubes; (or)
3 UV-199 tubes; (or)
3 DV-6-a tubes;
Fahnestock clips;
1 pound of No. 22 DCC copper wire;
connecting wire;
cabinet;
composition tubing.

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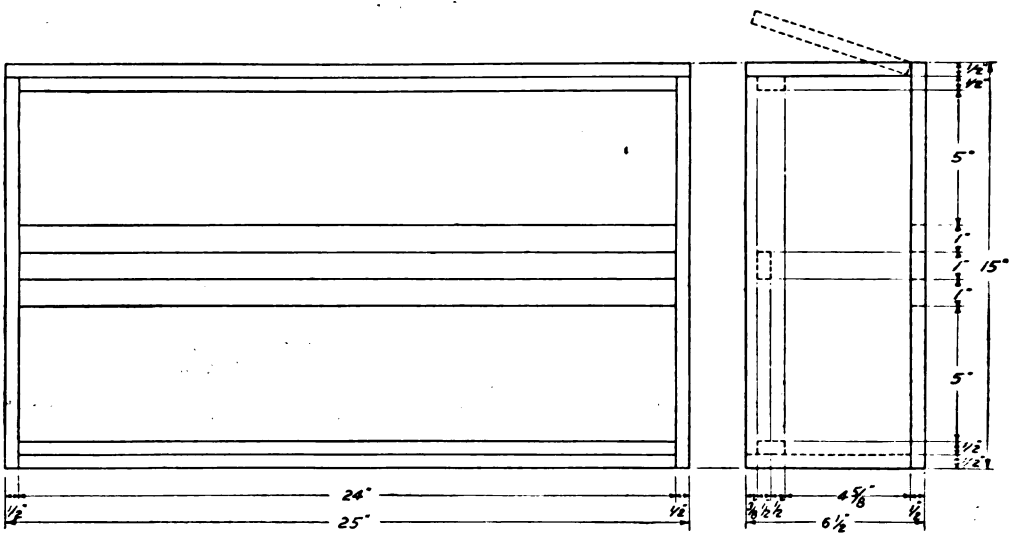
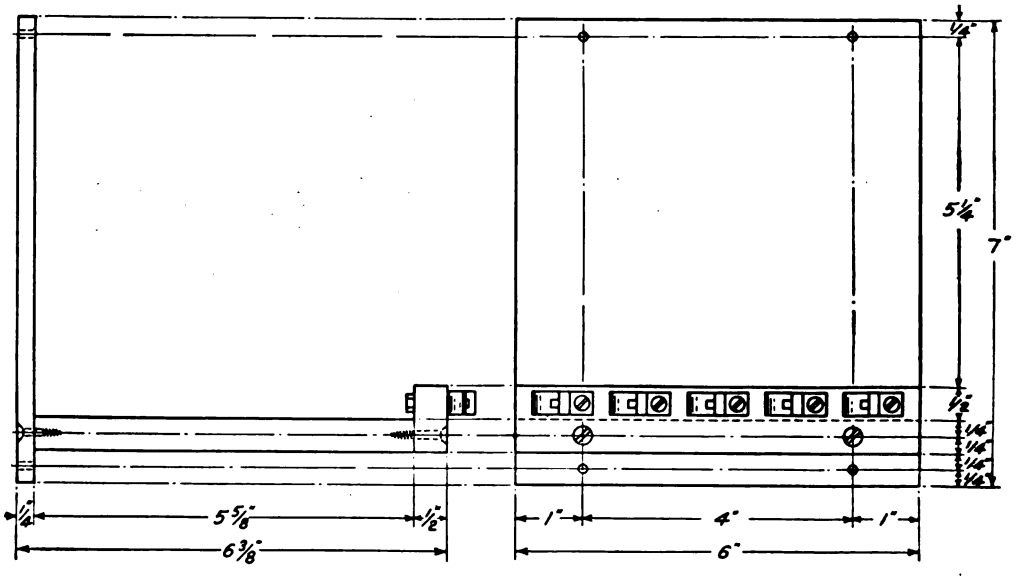


THE DIMENSIONS FOR THE CABINET

FIGURE 1: *Here are given the complete data for the size and shape of the box for holding the various units. This may be built by the fan himself or the drawing may be turned over to a cabinet maker who can build it from the instructions it contains.*



THE FRAME FOR THE UNITS

FIGURE 2: *At the left is given a side view of one of the frames and at the right is shown the rear view. The sizes for all of the sections are printed directly upon the drawing.*

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THE main features of the experimental receiving set discussed in this article may be summarized as follows:

(1) *Unit structure.* The set is composed of a cabinet and a certain number of interchangeable units, any of which may be inserted, taken out or changed without disturbing the others.

(2) *Appearance.* As all of the units are inclosed in one cabinet, this set does not present an unsightly appearance.

(3) *Facility with which the instruments may be connected so as to use any kind of receiving hook-up.* All the connections for the instruments in each unit are made by means of Fahnestock spring clips which are located at the rear of each unit. These clips may be connected in any desired combination and afford a quick and easy way to change from one hook-up to another.

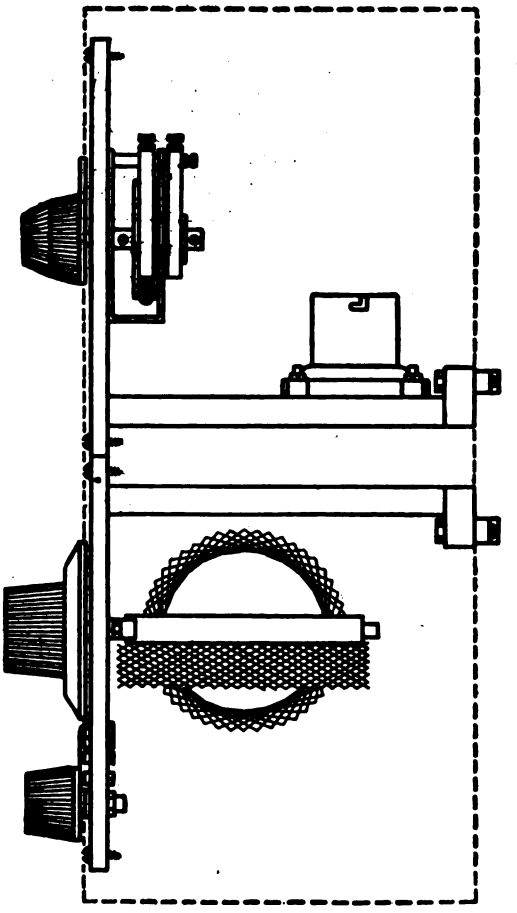
(4) *Efficiency.* The cabinet and units are so designed that the leads from unit to unit will be as short as possible.

This article gives instructions for the construction of a set consisting of eight units. Should the builder desire a greater or smaller number of units, the only change necessary is in the length of the cabinet. The unit make-up of this set permits the use of a large cabinet with only a few units—to which more may be added later without disturbing the original units in any way. It is, therefore, advisable to make the cabinet too large rather than too small—the extra space may be used for storing batteries.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electric circuit. The same designating letters are used in the text and the list of parts at the beginning of the article.

¶ *The list of parts there given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*



HOW THE UNITS FIT IN THE CABINET

FIGURE 3: *This drawing shows how the units fit in the cabinet with the upper units "right-side-up" and the lower ones "up-side-down." This makes for shorter connections when wiring a hook-up.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

How to Construct the Set

Figure 1 gives the specifications for the cabinet. This is made of some hardwood ½-inch thick and measures (outside dimensions) 25 inches wide by 15 inches high by 6½ inches deep. The top is hinged so as to permit access to the vacuum tubes. The front is open except for three horizontal strips, placed ⅜-inch in back of the front edge of the cabinet, to which the units can be screwed. The back is solid except for two horizontal slots, near the middle of the back and extending the length of the cabinet, in which fit the strips on which the spring clips are mounted. When the cabinet

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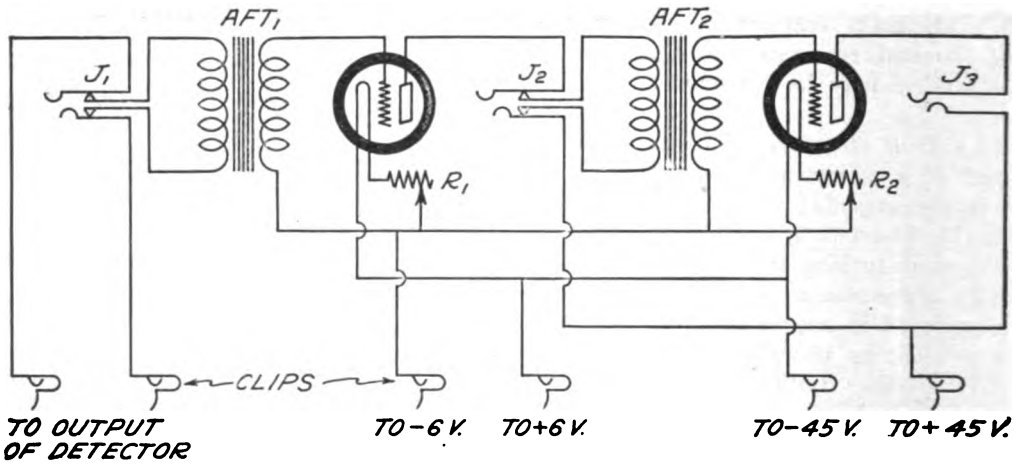


THE WIRING DIAGRAM FOR THE AMPLIFIERS

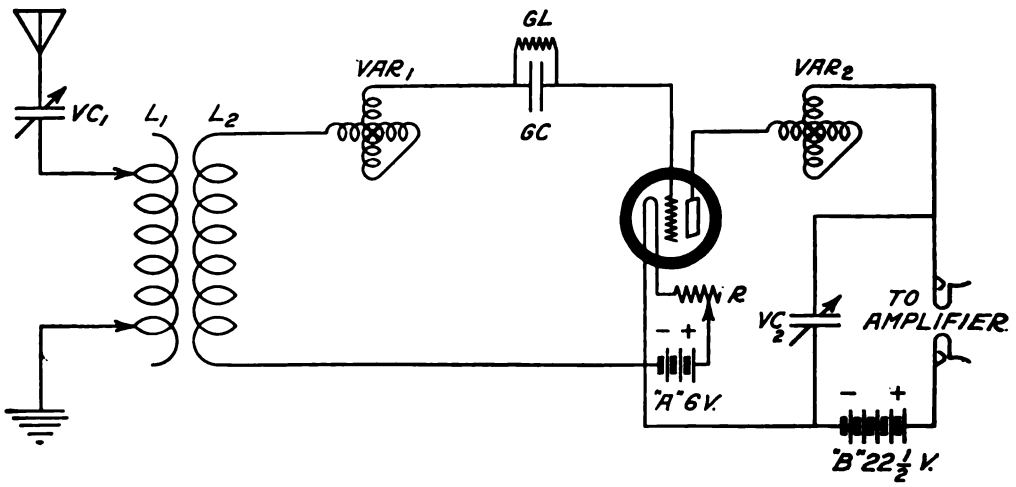
FIGURE 4: *A standard hook-up for the amplifiers is given in this diagram which shows the most efficient way to connect the instruments in the electrical circuit.*

has been assembled it should be stained and then shellaked or waxed.

Each unit consists of an instrument and a frame, which is identical for all units. The frame (see Figure 2) is made up of a panel 6 inches by 7 inches, a piece of ½-inch wood 5⅞ inches wide and 5⅝ inches deep that serves as a base and a piece of ½-inch wood, 1 inch by 6 inches, that is mounted at the rear of the base and to which the spring clips are bolted. Well dried quarter-inch, 3-ply wood, may be used for the panel but a composition or hard-rubber panel is better. Three-sixteenth inch composition may also be used for the connection strip; if this is done the base of the unit should be made 5⅞ inches deep instead of 5⅝ inches. Two screws, passing through the panel, fasten it to the base; the connection strip is fastened to the base in the same manner.

The placing of the panel holes, used in mounting the instruments, is left to the builder, as the position and size of the holes vary with the type of instruments used. Exterior connections to the units are made by means of the spring clips which are mounted on the connection strips and are electrically connected to the instruments in each unit. The connection strips should be marked in some manner so as to indicate the proper connections for the different clips, the number of which varies with the units.

In the front-view photograph the units are, from left to right, top row—variable condenser, .0005 mfd., detector, first stage of audio-fre-



ONE OF THE TUNING CIRCUITS THAT MAY BE USED

FIGURE 5: *This hook-up employs all the instruments in the set except the extra inductances contained in sections E and F.*

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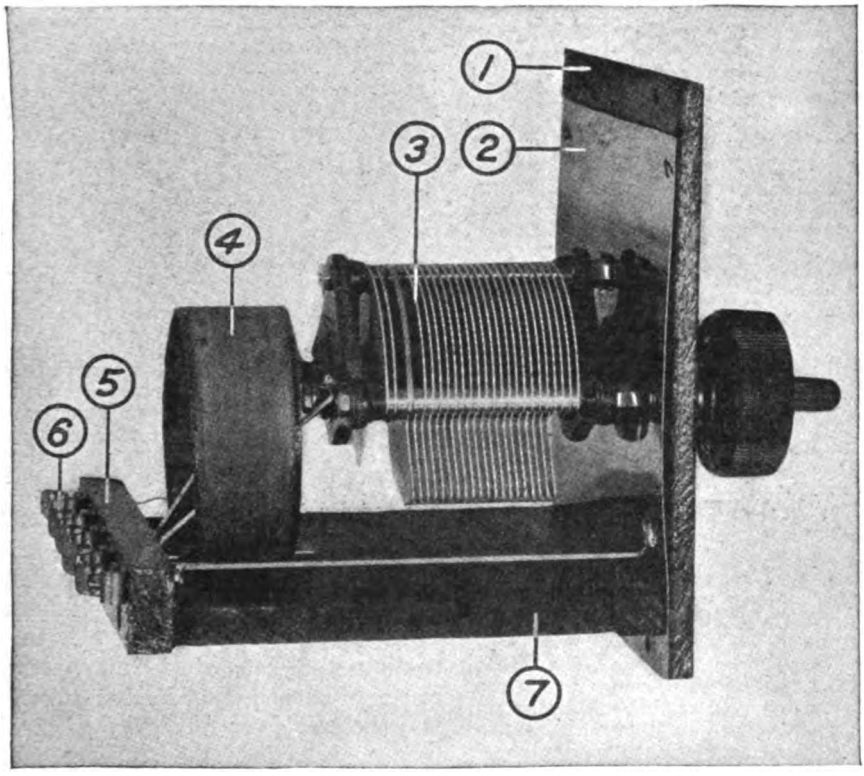

AN INTERIOR VIEW OF ONE OF THE UNITS

FIGURE 6: *This is unit F which contains a fixed coil and the .0015-mfd. variable condenser. 1 is the panel, carrying the shield, 2. 3 and 4 are the condenser and the coil. The frame 5 and 7 carries the clips 6.*

quency amplification, second stage of audio-frequency amplification; bottom row—variometer, variable condenser, .0015 mfd., variometer and variocoupler.

The builder may select his own instruments; the makes mentioned are those used in the original set, and give good results.

The .0005-mfd. condenser unit contains one Signal variable condenser, equipped with scale and pointer.

The detector unit contains one Cutler-Hammer vernier rheostat, one Chelsea standard vacuum-tube socket and one CRL variable grid-leak with a .00025 mfd. grid condenser. Both the tube socket and the grid-leak are mounted as far back on the unit base as possible, so as to make the connections short. This unit, as well as the amplifier units, need not be shielded.

The amplifier units are constructed differently from the other units. The panels are standard, but one piece of wood forms a base for *both* units, thus joining them. It is, therefore, possible to put all of the necessary apparatus for both stages of amplification in one standard unit. In the amplifier unit, jacks are provided, not only for one and two stages of amplification, but also for the detector. Two double-circuit and one single-circuit Frost jacks, two rheostats, two tube sockets and two Jefferson audio-frequency amplifying transformers are used. The internal wiring diagram for these units is shown in Figure 4. Place the tube sockets well to the rear of the base and run the connecting wires in as short paths as possible.

If the builder desires to use vacuum tubes other than those having standard bases he should, of course, use tube sockets that will fit them, instead of using standard sockets. In the original set a UV-200 was used as a detector and two UV-201-a tubes as amplifiers, but either WD-11 tubes or UV-199 tubes give excellent results. Both WD-11 and UV-199 tubes operate with dry-cell "A" batteries, thus obviating the necessity for a storage battery. If UV-199 tubes are used, 30-ohm rheostats should be substituted for the ordinary 5-ohm rheostats, as the latter will not control tubes having such a low filament consumption.

Amrad basket-wound variometers are used in both of the variometer units. One of the units contains only the variometer and shield and is equipped with a 4-inch dial. The other unit contains, beside the variometer, dial and shield, an inductive winding placed at one side of the variometer. This inductance consists of 64 turns of No. 22 DCC wire triple-bank-

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wound on a 4-inch tube in the same direction as the stator winding of the variometer, to which it is inductively (not conductively) coupled. This winding is tapped and controlled by means of two switches located on the panel. A second inductive winding consisting of 15 turns of wire may be placed next to the first one, if desired. This will permit the use of the "DX" regenerative circuit published in POPULAR RADIO for January, 1923. Even if this winding is not added, the first inductance will admit of many uses.

The .0015-mfd. condenser is a Fada vernier condenser. This unit is shielded and is equipped with a 4-inch dial; the knob of which has been drilled to permit the vernier rod to pass through it. An inductance consisting of 25 turns of No. 22 DCC wire on a 4-inch tube is also mounted in this unit. This inductance is *not* connected to the condenser—its ends are connected to two spring clips—but it finds use in some hook-ups as a loading coil or, in connection with a condenser, as a wavetrap. A piece of shim brass or sheet copper is fastened to the back of the panel and connected to a clip. This is connected to the ground when the set is in operation and serves as a shield against body capacity when the set is being tuned. Cut the shield clear of all "live" parts of the instrument.

The variocoupler unit consists of a Hilco variocoupler, a dial and the necessary switches. A 150-turn loading coil, triple-bank-wound on a 4-inch tube and tapped every 50 turns is also provided. A third small switch on the panel is used to cut this coil out or insert it in series with the primary of the variocoupler in 50-turn steps. This unit should also be shielded.

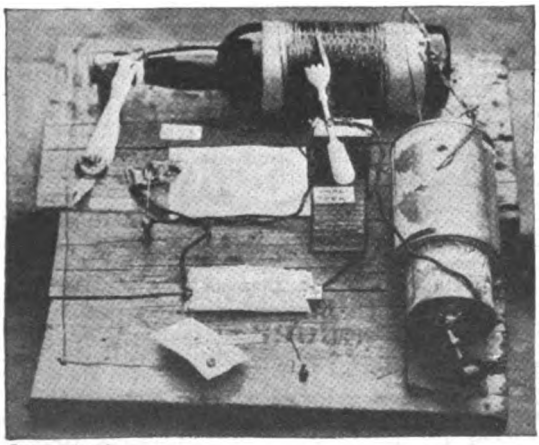
Figure 3 shows the manner in which the units fit in the cabinet. The upper row of units is placed in the cabinet "right side up" and the lower row "upside down." Thus the spring clips, which project from the back of the cabinet, are placed close together and the connections are short.

How to Wire the Set

The set is connected up by means of ordinary single-strand wire. This wire should be cut into strips of varying lengths, each of which should be "skinned" for ½-inch at each end. When connecting up the units these bare ends are secured by means of the spring clips which are thus connected together in such a manner as to secure the desired hook-up. The connections within the units are made of 1/16-inch square tinned-copper bus-wire.

When the set has been finished it will be found to be very easy to connect the clips together in such a manner as to use any one of a great number of hook-ups. After a little experience it will be possible to change from one hook-up to another in one or two minutes, and practically any desired hook-up may be tried out. A spiderweb or honeycomb-coil unit may be constructed and new units may be added as new hook-ups come out; thus the set never grows old. Figure 5 shows one that employs all of the instruments.

It is manifestly impossible to describe the tuning of this set, as the tuning operations differ with the hook-ups used. It is easy to make a mistake in connecting the set which may, perhaps, cause a burned-out vacuum tube. Always check over the wiring carefully before inserting the tubes in their sockets. An advisable precaution is to disconnect the positive "B" battery, insert the tubes in their sockets, and then see if the filaments light properly. If all seems in good working order the chances are slight that the re-connection of the "B" battery will burn out a tube.



International

A "JUNK" RECEIVER BUILT BY A MODERN CRUSOE

Here is a workable receiving set made from nothing but beachcombers' materials that are washed up on the seashore. The coil is wound on a bottle, the variable condenser comprises two tin cans, the base is a piece of driftwood, the tuning slider is an ordinary fork with a few teeth removed, and the fixed condenser is made of dried paper and tinfoil. If you were ever shipwrecked on a desert isle, this would be a practical set to build.

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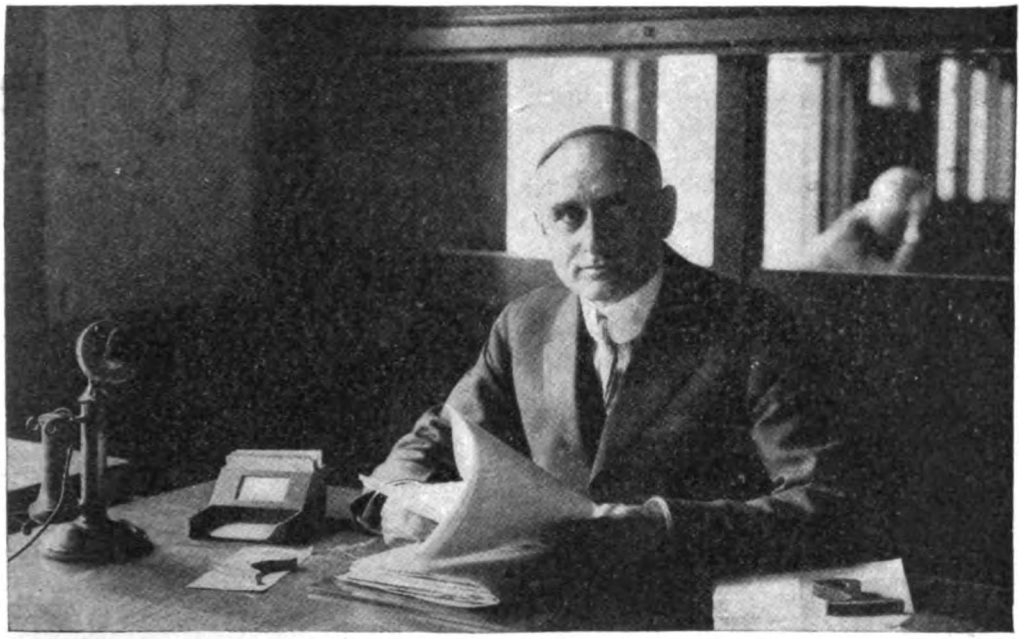

THE MAN BEHIND "THE MOST INTERESTING EXPERIMENT IN EDUCATION IN THIS COUNTRY"

Arthur E. Morgan, the progressive president of Antioch College in Ohio, who has undertaken to "broadcast education" with the aid of the station maintained by his institution.

Will Radio "Revolutionize" American Educational Methods?

Some people think that it will—particularly the faculty of Antioch College, which is undertaking to demonstrate how broadcast programs can be made both entertaining and informative, and that the first requisite of an educational course is that it be interesting.

By HARRY A. MOUNT

ARTHUR E. MORGAN revolutionized flood-prevention engineering. When he laid his plans for the $35,000,000 Miami Conservancy project, to protect the city of Dayton and other cities of the Miami Valley from a repetition of the disastrous flood of 1913, he found engineering opinion of the country almost unanimously against him. The thing had never been done that way before. Even the people of Dayton began to be doubtful and the whole project might have been wrecked. But—

Morgan invited not only his critics, but many hydraulic engineers of note to come to Dayton at his expense and spend as much time as they liked going over his plans. That was all he asked. They came—one of the newspapers said they came in droves—and almost to a man

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they went away satisfied that Arthur Morgan had found a simple, logical way to prevent floods. One eminent engineer, who had been one of the severest critics, actually spent several months in Mr. Morgan's office and monopolized a good part of the office force during that time but he went away a warm supporter of the plan.

"And it was his approval," said Mr. Morgan later, "which did more than anything else toward putting the plan across."

Now Mr. Morgan (who has become president of Antioch College) has undertaken an even more difficult task. This time he has undertaken nothing short of a revolution of American educational methods and some of the best minds of this country believe he will succeed.

Dr. Charles W. Eliot has called Mr. Morgan's new project "the most interesting experiment in education going on in this country." Again there is a hard fight to build up interest in and knowledge of a new project, among people already surfeited with "interests." In this new fight Mr. Morgan has found a new ally. Between the quaint old towers of the main college hall one can make out the strands of a radio antenna and in one of the upper rooms of the building is a modern broadcasting station.

The new ally is radio!

We may find, when Mr. Morgan has finished this job, that he has not only revolutionized higher education, but that he has revolutionized the use of radio for educational purposes as well. There are going to be no tiresome speeches on educational methods from station WRAV (those are the call letters). Nor will there be any courses broadcast for volunteer students.

Why?

"Because," said Mr. Morgan, "nobody would listen to them. My son is a radio enthusiast and we have a receiving set at home. I know that no one in our family listens to long talks by radio, unless they are of extraordinary interest. As a rule, when a talk is announced we immediately begin hunting for another station that offers some lighter entertainment.

"We have a serious subject to present to an audience which will walk out on us if we broach a serious subject. How can we do it? Well, if we are to have an audience at all, we shall have to give them what they want. The body of our programs will be made up of music furnished largely of course by students and student organizations. Occasionally we will have a short talk by one of the teaching staff—and we will make it plain in the announcement that the talk will not be longer than five minutes—on some current topic in the day's news; not just a summary of the news, but an interpretation of the news.

"For instance, there is an earthquake in Japan. That very evening our Professor of Geology delivers a short talk on the cause of earthquakes and the probable cause of this one. And then in a few sentences he will tell why every well educated person should know the rudiments of that science. In a similar way we would like to demonstrate that no man is educated unless he knows how to handle his personal finances so as to remain solvent, or until he can temper the theory of his text-books with the fire of practical experience.

"We are planning no courses of study for broadcasting. I do not believe it is at present possible to obtain an education in that way. Education is not merely accumulated knowledge; it is *coordinated* knowledge. That can best be obtained at school. Let me illustrate:

"The usual course in obtaining an education is first to study the cultural subjects—literature, sociology, languages and the like—with perhaps a smattering of chemistry and physics. The student next takes a technical course, in which he becomes proficient in his chosen profession. Finally he enters professional life, and no one will deny, I think, that his education is not complete until he has developed practical judgment.

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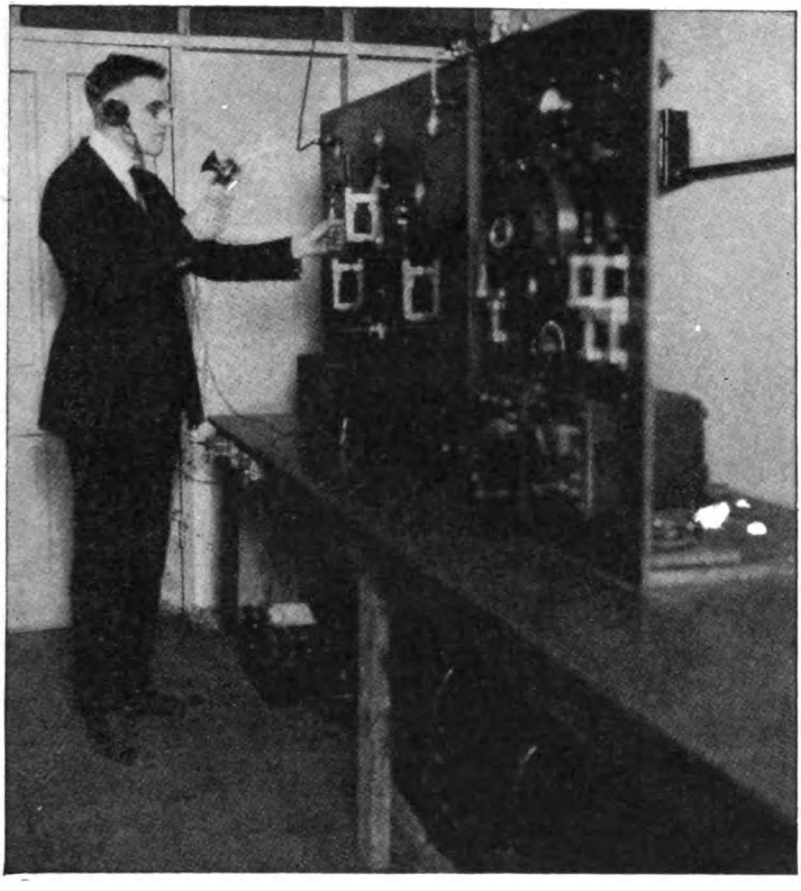

THE TRANSMITTING SET OF THE COLLEGE

Unless the "educational programs" that are broadcast are made interesting, fans will not listen in. To meet this condition may upset many old theories of what "education" really is.

"Now, one might as well decide to exercise the arms for a year to develop them, and then exercise the legs for a year. Mental development as well as physical goes on *all over* at the same time. If we exercise one mental function and neglect the others the result is as grotesque as a physical body with well developed arms and dwarfed legs. I know a college president who has six servants in his home, yet he cannot pay his grocery bill. I know professional men who are fine technicians but who are flat failures in their relations with other men and women. Such men are the natural products of our tandem system of education, and they are not educated. Education is coordinated knowledge and that is impossible by radio. We are not going to try to educate people by radio, but we are going to try to create a desire for education, and we are going to try to 'sell' the public our idea of what an education is. And we are going to do it a sentence at a time."

Antioch College is located at Yellow Springs, Ohio. Mr. Morgan found it not far from one of the big dams above Dayton. It was a little struggling institution, scarcely known beyond a twenty-five mile radius. It was founded some three-quarters of a century ago by the great educator, Horace Mann, who, thwarted

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ONE OF THE MOST SIGNIFICANT RADIO STATIONS IN THE COUNTRY

The main building of Antioch College, which operates station WRAV for the purpose of extending the institution's influence among the people of Ohio. (The antenna masts and wires have been retouched on this picture.)

by sectarian interference, died there with his dream of an ideal American college unfulfilled. The buildings were mellowed, ivy covered their walls; the paint inside was faded and the rooms were even more bare, but otherwise the old school had changed not one whit from the days of Horace Mann.

It is a little over three years now since Arthur Morgan gave up an engineering practise with a satisfactory income to become head of Antioch. Already there is abundant evidence of a physical rejuvenation, and the eyes of the whole educational world have been turned expectantly to the experiment in education being carried out there.

At Antioch the student spends half of his time working for wages at the profession which he expects to enter. Mr. Morgan's son, who expects to follow in the footsteps of his father, is working with a pick and shovel at laborer's pay on a dam above Columbus. He worked in a cement mill and carried about five tons of cement a day on his back as part of the process of obtaining an education.

The students are divided into two shifts, which work and go to school in alternate periods of five weeks. About a hundred and twenty industries, located within twenty-five miles of the school are cooperating in this program. Two students are assigned to each job and they work at it alternately; one goes to school while the other works. The school period, in turn, is divided about equally between cultural and technical subjects. Many of the students expect to start life as proprietors of small businesses and these, in their later school days, are expected to conduct small business enterprises upon their own initiative and responsibility, but under the supervision of their instructors. The college finances such undertakings and shares in the

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profits. Already under this plan students have purchased the town newspaper office and are conducting a publishing and printing business. Another group has opened a clothing store, others run the college book store, others a tea room, and others a tooled-leather business. It is planned to erect on the campus a modern industrial building, with a power plant, to furnish space to a number of selected industries, which in turn will give employment and experience to students.

Not only do students keep in touch with practical affairs by working at them, but the faculty follows a similar plan so far as is practicable. For instance, the Professor of Accounting is head of the Dayton office of a large accounting firm and he divides his time between Dayton and Antioch. Not only does this keep him in practical touch with his subject, but part of what he earns at Dayton applies on his salary as instructor, and his office furnishes employment for some of his advanced pupils.

The primary object of the scheme is to obtain such a balance between theory and experience that the graduate can take up his full responsibilities in daily life without paying the usual penalty for inexperience. Secondary objects are to enable students to earn part or all of their expenses while at college, to secure better instructors at less expense to the school, and finally to make the college independent of donations and foundations.

And that is what Antioch has to "sell" by radio.

The transmitting set now at the school is not a powerful one, as broadcasting stations go. Most of the well-known broadcasting stations employ a power of 500 watts, while the Antioch station has a power of 150 watts. This is sufficient, however, to reach the near-by communities where their constant listeners are.

The apparatus is under the supervision of the Professor of Physics, John G. Frayne, who is a practical communication engineer. The broadcasting equipment was given to the college by a Dayton department store and has since been almost entirely rebuilt at the school. The quality of transmission has been brought up to excellence, although the station is still in need of a super-sensitive microphone and other minor pieces of equipment.

Westinghouse

RADIO'S BLIND CRITIC

A unique figure in the radio world is Miss Marjory Stewart, a blind graduate of the University of Pittsburgh, who is the "radio program literary critic" of a broadcasting station—said to be the only position of its kind in the world. Her daily reviews of the features on the KDKA schedules is an important factor in determining that station's policies.

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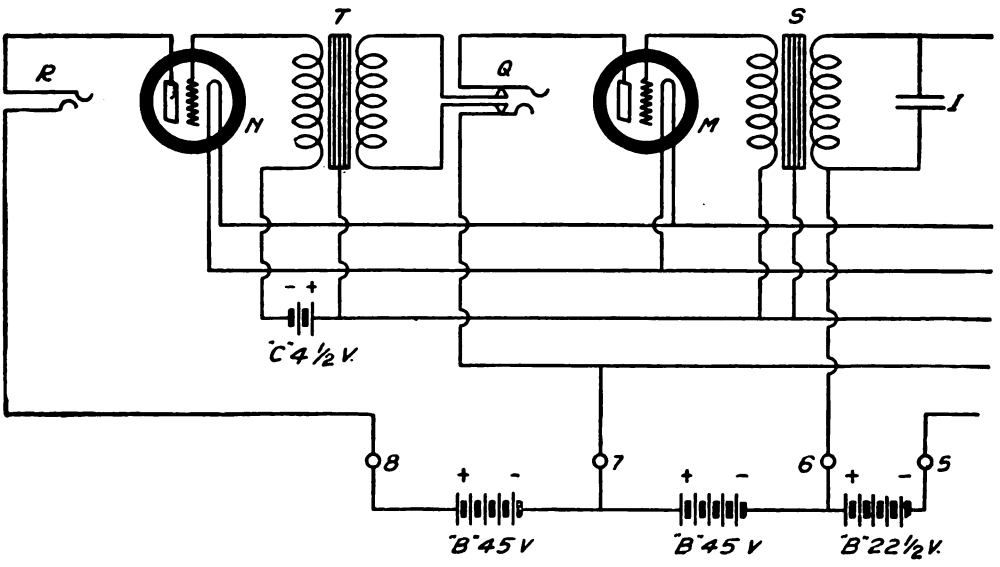

THE WIRING DIAGRAM OF THE ELECTRICAL CIRCUIT

FIGURE 1: *Notice that this diagram reads* FROM RIGHT TO LEFT *instead of from left to right, which is exactly like the set as looked at from the rear, in wiring.*

HOW TO BUILD A NON-REGENERATIVE

TUNED-RADIO-FREQUENCY RECEIVER

By ALBERT G. CRAIG

Here is a plate-tuned radio-frequency receiver that embodies the neutrodyne principle by means of a real Wheatstone bridge arrangement. Eliminating the tuning from the grid circuit of the detector tube reduces the losses in that circuit and makes for added sensitivity. This circuit is notable for its ease of control, distance range, and clarity of reception.

COST OF PARTS: *About $70.00*

RECEIVING RANGE: *Up to 3,000 Miles*

HERE ARE THE ITEMS YOU WILL NEED—

A and B—special variocoupler;
C and D—radio-frequency transformer;
E—Cardwell .0005 mfd. (21-plate) condenser;
F—Cardwell .001 mfd. (41-plate) condenser;
G—Cardwell .00025 mfd. (11-plate) condenser;
H—Dubilier mica fixed condenser .00025 mfd. (with grid-leak clips);
I—Dubilier mica fixed condenser .0025 mfd.;
J—Daven grid-leak 3 megohms;
K, L, M and N—Alden-Napier standard sockets (type 400);
O and P—Cutler-Hammer rheostats (6 ohms);
Q—Federal double-circuit jack;
R—Federal single-circuit jack;
S—Amertran transformer 5 to 1 ratio;
T—General Radio transformer 3½ to 1 ratio;
U—Cutler-Hammer filament switch;
V—Amsco switch lever;
W—switch points and stops;
X, Y and Z—composition panel, hardwood subbase and cabinet;
A1—binding-post panel (1 inch by 10 inches by 3/16 inch);
AK—condenser brackets;
8 Eby binding posts;
machine screws; wood screws; bus-wire;
1 UV-200 or C-300 and 3 UV-201-a or C-301-a vacuum tubes;
"A" battery (6-volt storage);
"B" batteries (total 112½ volts);
"C" battery, Eveready 4½-volt, No. 751.

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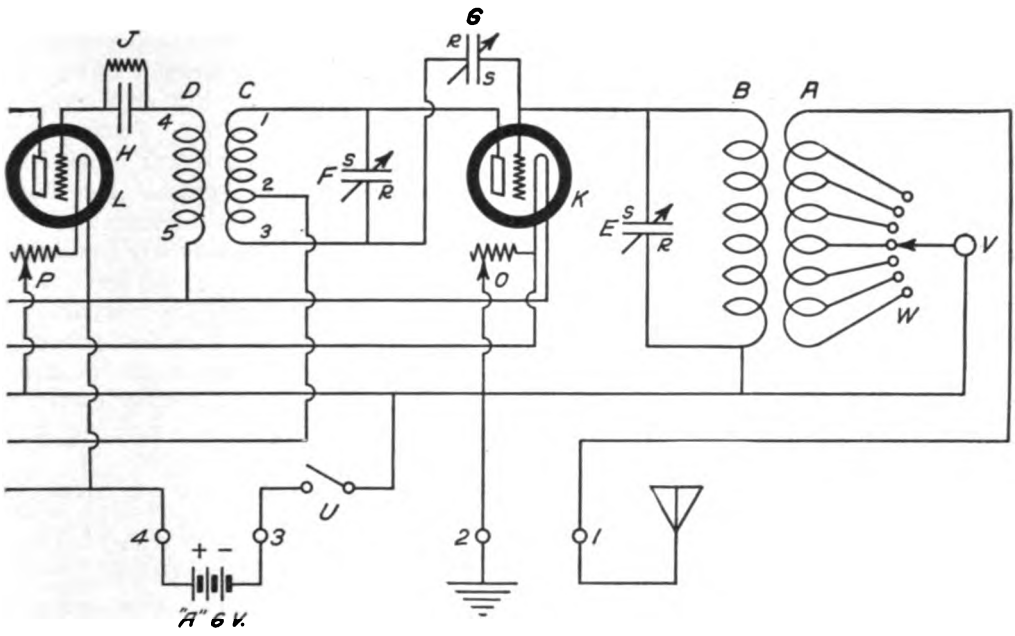

THE editors of POPULAR RADIO have been literally deluged with persistent demands for a radio circuit that employs one stage of radio-frequency amplification; often the reader wants to add one stage of radio-frequency amplification to his regenerative set.

This has been generally discouraged because of the fact that the circuit would become complicated in operation and only in rare cases would louder signals be obtained; indeed, the latter is especially true if an attempt is made to add only a single stage of transformer-coupled radio-frequency amplification, in which the oscillation of the radio-frequency tube is controlled by means of a potentiometer.

The potentiometer method of control is inherently wrong, as it applies an increasing *positive* potential to the grid with respect to the filament, while the grid should be *negative* for best amplification. Also, as the plate circuit of the radio-frequency tube is being tuned, the tendency towards oscillation increases.

On the other hand, the control of oscillation by neutralizing the grid-plate capacity of the radio-frequency tube offers a solution for both of the above difficulties. The grid of the radio-frequency tube can be operated at a negative potential for obtaining maximum amplification and the plate circuit of the radio-frequency tube can be tuned exactly to the wavelength of the incoming signal. The capacity of the tube is neutralized in this case by means of a Wheatstone bridge arrangement. The tube capacity and the plate inductance constitute one side of the bridge, while an extra inductance and extra capacity form the other arm of the bridge. The two inductances tend to send the radio-frequency current in opposite directions at the same time and the net result is zero current through the tube capacity.

The circuit of the receiver described in this article consists of one stage of tuned radio-frequency (using the principle of neutralization of tube capacity mentioned above), detector, and two stages of transformer-coupled, audio-frequency amplification. It will give considerably stronger signals than the three-tube standard regenerative receiver.

The two notable advantages of this circuit are:

First; it will not re-radiate and;

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Second; it always gives clear reception.

The first advantage means that the experimenter cannot disturb his neighbor, with one squeal after another, as he tunes in the various stations. One must be an expert operator to use some of the closely coupled regenerative receivers, and it may even be suspected that experts are inclined to tune in distant stations by the whistle method. There are, in fact, many campaigns on, at the present time, against just this form of interference.

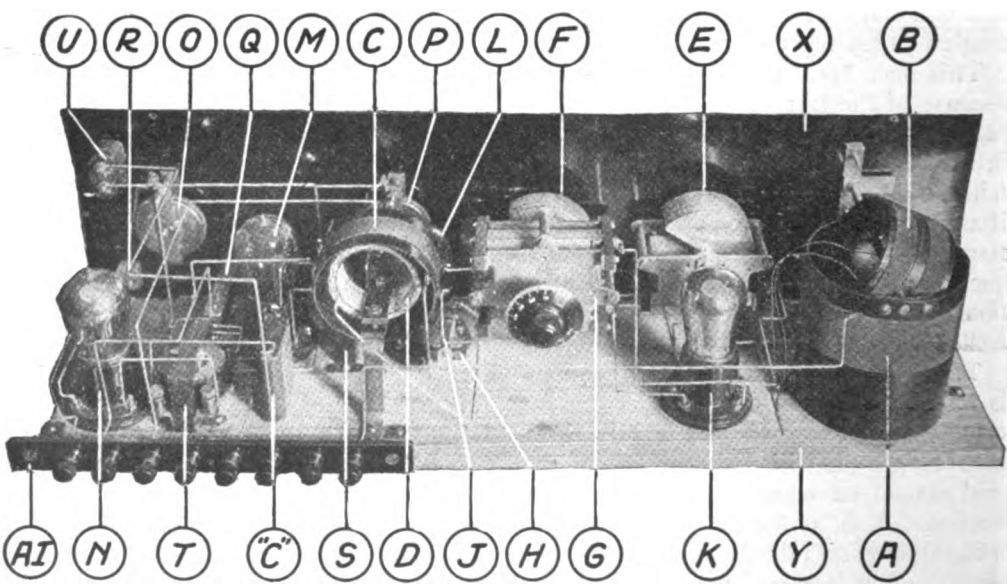
The second advantage means that the experimenter cannot make the music or speech signals from a station sound badly even if he tries. All he has to do is to adjust the tuning controls for maximum signal strength—the quality of signal remains the same always. With most regenerative receivers the adjustment is usually a compromise between clarity and strength of signal.

The number of controls in this receiver is the same as for the regenerative receiver of the loosely coupled type. The condenser of the single stage of radio frequency replaces the regeneration control while the other controls—the primary and the secondary wavelength and the coupling—are the same in both instances. While some sets use a fixed primary and employ fixed coupling, it was decided to make both of these *variable* for those who desire the highest refinements. If one is satisfied with either fixed primary or fixed coupling, or both, the best values may be determined by experiment and the controls may be left in that position. For any given coupling a tuning chart may be made up for the other controls. (This will be explained later in this article.)

The wiring diagram of the circuit is shown in Figure 1.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electric circuit. The same designating letters are used in the text and the list of parts at the beginning of the article.



INTERIOR VIEW OF THE RECEIVER, FROM THE REAR

FIGURE 2: *This picture shows how the instruments are mounted on the base and the panel. Notice that the neutralizing condenser G, is supported by the tuning condenser F.*

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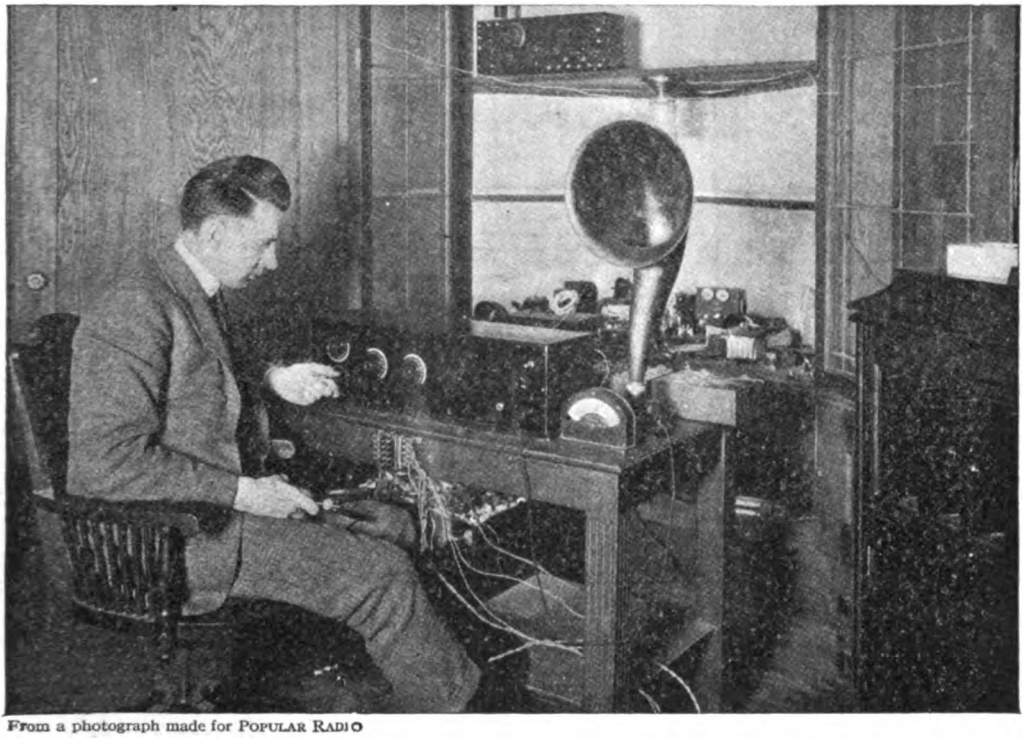

From a photograph made for POPULAR RADIO

THE COMPLETED SET INSTALLED IN THE LABORATORY

The author, Mr. Craig, and the Technical Editor tested out the receiver on distant signals on antennas of various lengths, from 25 feet to 150 feet. The results were remarkable for clarity and truthful reproduction, from all signals both local and distant.

The list of parts there given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel for mounting them.

How to Construct the Set

After procuring all the instruments and materials for building the set, the amateur should prepare the panel X, (shown in Figures 2, 3, 4, 5 and 6).

First of all, cut the panel to the correct size, 7 by 26 inches.

Then, square up the edges smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 6. A convenient method of doing this is to lay out all center holes on a piece of paper the same size as the panel; then the piece of paper should be pasted on the panel and the centers marked directly on the panel by punching through the paper.

The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in the panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that must go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with fine sandpaper until the surface is smooth; then the same process should be repeated, except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth; a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during the drilling.

The sub-base Y (see Figures 2, 3, 4 and 5), should be cut to size, 7 by 25 inches. If a piece of ½-inch hardwood, surfaced on both sides, can be obtained the work of squaring up and finishing the edges will be a minimum.

The special coupler, composed of the coils A and B, can now be constructed as shown in detail in Figure 8.

Cut the composition tube, for the primary

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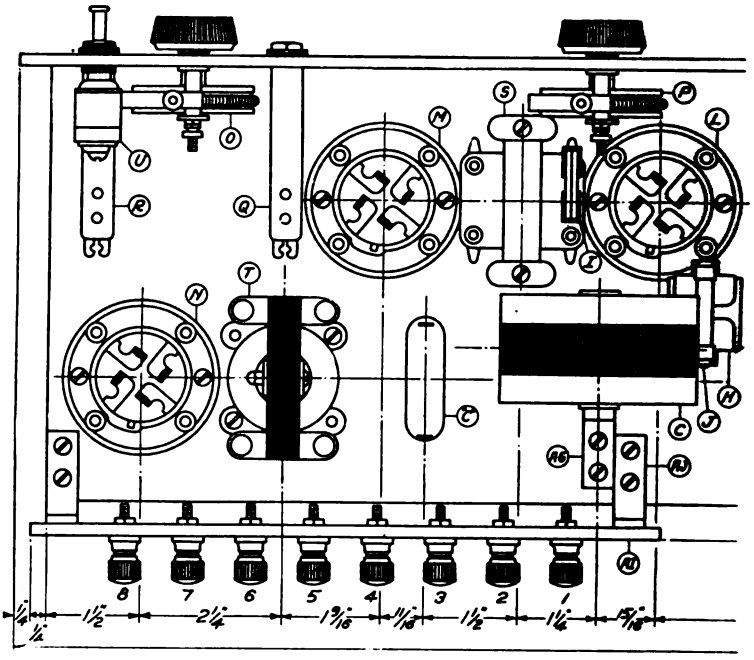

THE WORKING DRAWING FOR CONSTRUCTION

FIGURE 3: *Here are shown the correct positions for the various instruments. The positions are given on the diagram, center to center, for all instruments.*

coil A, to size and drill the holes for the rear bearing of the coupler AA, the two angle brackets AB and one hole for the shaft in the front of the tube. Cut away the material above this latter hole so that the shaft can be slipped down into place later on. Wind the coil with No. 22 DSC wire, beginning ½ inch from the top of the tube. Taps are taken off at the 3rd, 7th, 12th, 19th, 28th, 40th and 56th turns.

Cut the composition tube, for the secondary coil B, to size and drill the holes for the shaft and the two machine screws shown. Wind 21 turns of No. 22 DSC wire on one side of the shaft hole, beginning 3/16 inch from the edge of the tube. Then bring the wire over and wind 21 more turns on the other side of the shaft hole. Make the rear bearing AA, the front bearing AE, the arm AF, which strikes the stops, the two pieces AC, for connecting the rotor and shaft, the two angle brackets AB, all out of ⅛ by ½-inch strip brass. The shaft AD consists of a piece of ¼-inch brass rod 7½ inches long (see Figure 8).

To assemble the coupler fasten the rear bearing AA and the two angle brackets AB to the primary tube A with 6-32 brass machine screws. Fasten the two lugs AC to the rotor or secondary tube B with machine screws, then pass the shaft AD through the holes in the rotor and solder it to the lugs AC. The remainder of the assembly will be taken care of later when the instruments are mounted.

Next, construct the radio-frequency transformer C and D as shown in Figure 9.

Cut the composition tube for the primary coil C to size, and drill two holes for the mounting bracket AG. Wind 28 turns, of No. 22 DSC wire, centrally on the tube, taking off a tap on the opposite side of the tube half way between the 25th and 26th turn. The width of the winding will be about ¾ of an inch. The secondary coil D is a 75-turn Pacent duolateral coil. Make the mounting bracket AG out of ⅛ by ½-inch brass strip

Cut two small clamping strips AH out of composition sheet. Assemble the transformer by passing two brass machine screws first through the tube C, then through the bracket AG and one of the clamping strips AH. Place the duolateral coil in position and fasten the other clamping strip AH down with nuts on the machine screws.

Now, cut the binding-post panel AI out of composition sheet and drill as shown in Figure 10. Then make the two angle brackets AJ for mounting the binding-post panel out of ⅛ by ½-inch strip brass, and fasten them to the panel. The brackets AK, for mounting condenser G on the back of condenser E are also shown in Figure 10. Make them also out of ⅛ by ½-inch strip brass.

Complete specifications for constructing the cabinet Z, are shown in Figure 7. It may be constructed out of ½-inch hardwood such as mahogany, walnut or oak, and finished to suit

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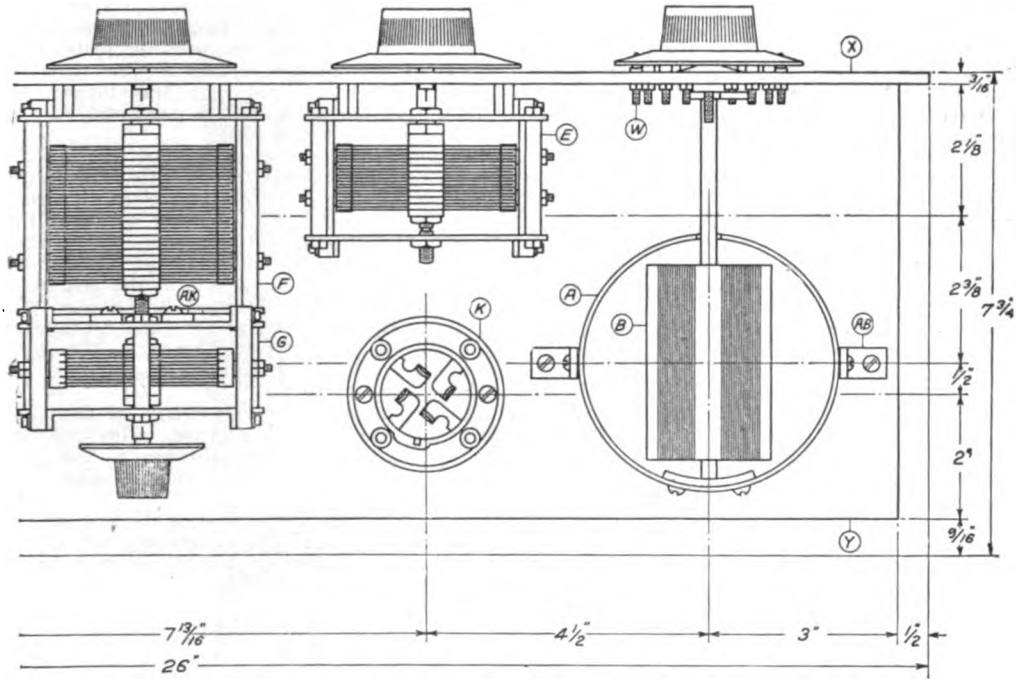

the taste of the builder. Or the cabinet may be purchased complete from your radio dealer, as it is a standard size. In the latter case it will only be necessary to cut the slot in the back of the cabinet for the binding-post panel.

How to Mount the Apparatus

Preliminary to mounting the parts of the set, fasten the panel X to the sub-base Y, (see Figures 2, 3, 4 and 5). Make sure these two are fastened exactly at right angles.

Fasten the sockets K, L, M and N to the sub-base with wood screws in the positions shown in Figure 3. Note that the slot in the socket is towards the rear *in each case.*

Mount the transformer S with the primary towards the socket L and the secondary towards socket M, and mount the transformer T with the secondary towards the rear of the set. The exact location for each is shown in Figure 3.

Secure the radio-frequency transformer C and D to the sub-base with two wood screws inserted through the mounting bracket as shown in Figures 2 and 3.

The remainder of the coupler assembly can now be carried out.

Fasten the primary coil A in the position shown in Figures 2, 3 and 4. Then place the stop arm AF and the front bearing AE on the shaft of the rotor. Pass the rotor shaft through panel X, drop the rotor into position and insert the shaft in the rear bearing AA. Secure the front bearing AE to the panel with machine screws which project about ¼ inch beyond the bearing to act as stops. Move the stop arm AF up against the front bearing and solder it to the shaft in such a position that it strikes one of the stops at zero coupling, that is, with the rotor at right angles to the primary coil. Before soldering see that the direction of rotation from the zero point corresponds with an increase in coupling as indicated on the dial to be used. A spring washer should be inserted between the dial and the panel to take care of any end play.

Mount the jacks Q and R on the panel as shown in Figures 3 and 5. The frames of the jacks are turned up.

Fasten the two rheostats O and P to the panel in the position indicated in Figures 2, 3 and 5. The terminals are towards the top.

Now, mount the two variable condensers E and F on the panel. The correct positions are shown in Figures 2 and 3.

By means of the small mounting brackets AK (shown in Figure 10) mount the condenser G on the back of the condenser F as indicated in Figures 2 and 3. The holes for these brackets are already drilled in the condensers and are tapped with a 6-32 thread, one being found on each side of the bearing.

Next, mount the battery switch U in position as shown in Figures 2, 3 and 5. The construction work on the set is now complete.

How to Wire the Set

When wiring, it should be remembered that all connections from the high-voltage side of the transformers or coils (that is to say the side next to the vacuum tubes) should be kept about ½ inch away from other wiring and should not run parallel to it for any considerable distance. This also includes the wir-

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ing from the radio-frequency transformer to the condenser G.

Use tinned-copper bus-wire throughout. All connections should be bent into the proper shape and then soldered in place.

Start wiring the filament-lighting circuit as shown in Figure 1. The filament circuit passes along the front of the set towards the bottom of the panel and it includes the positive and negative terminals of sockets K, L, M and N, the rheostats O and P, the filament switch U, the negative "A" battery binding post (No. 3), switch arm to ground binding post, (No. 2).

Now, wire up the antenna and ground circuit. The antenna binding post No. 1 connects to the top of the primary coil A, (the end with few turns between taps). Connect the remaining seven taps to the switch points and the switch arm to the ground binding post, (No. 2).

Connect up the grid circuit of the radio-frequency tube which comprises secondary coil B, condenser E, the grid terminal of vacuum-tube socket K and the negative "A" battery. The stationary and revolving plates of all the condensers are marked S and R respectively in the wiring diagram. The connections to the secondary coil B should be made with flexible silk-covered wire.

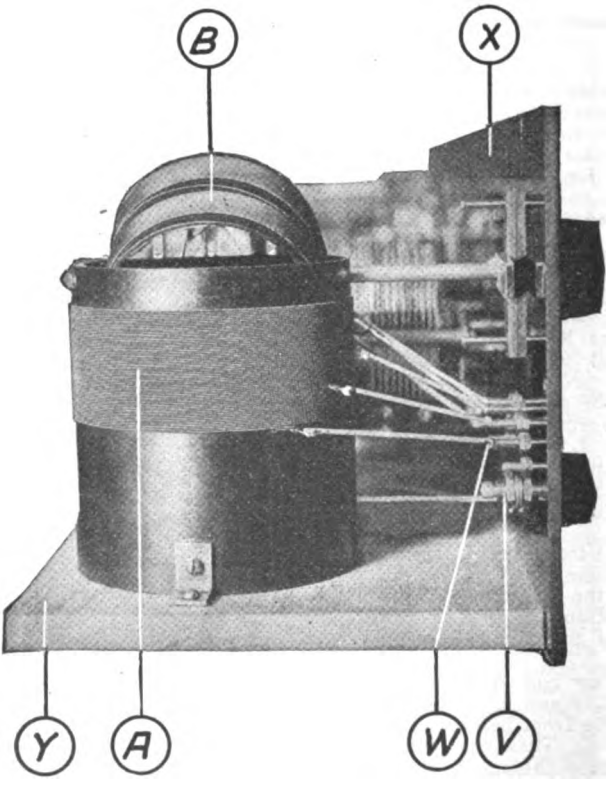
Then, wire the plate circuit of the radio-frequency tube. This embraces the plate terminal of vacuum-tube socket K, the primary coil of the radio-frequency transformer C, condensers F and G, and the positive 67½-volt binding post, (No. 7).

Connect up the secondary of the radio-frequency transformer D, the grid-leak J, the grid condenser H, the grid terminal of socket L and the positive "A" battery to form the grid circuit of the detector tube. Note that the grid condenser J is supported by the two bus-wires used to connect it in the circuit.

Wire up the plate circuit of the detector tube which comprises the plate terminal of socket L, the primary of transformer S, the condenser I, and the positive 22½-volt binding post, (No. 6).

Next, connect the grid circuit of the first audio-frequency amplifier tube. This consists of the secondary of transformer S, the grid terminal of socket M and the negative "A" battery.

Now, wire the plate circuit of the first amplifier tube, embracing the primary of transformer T, the jack Q and the positive 67½-volt binding post, (No. 7).



VIEW OF THE SET, FROM THE LEFT

FIGURE 4: *Here is shown the manner of mounting the primary coil A and the secondary coil B, with the taps running to the switch points on the panel X.*

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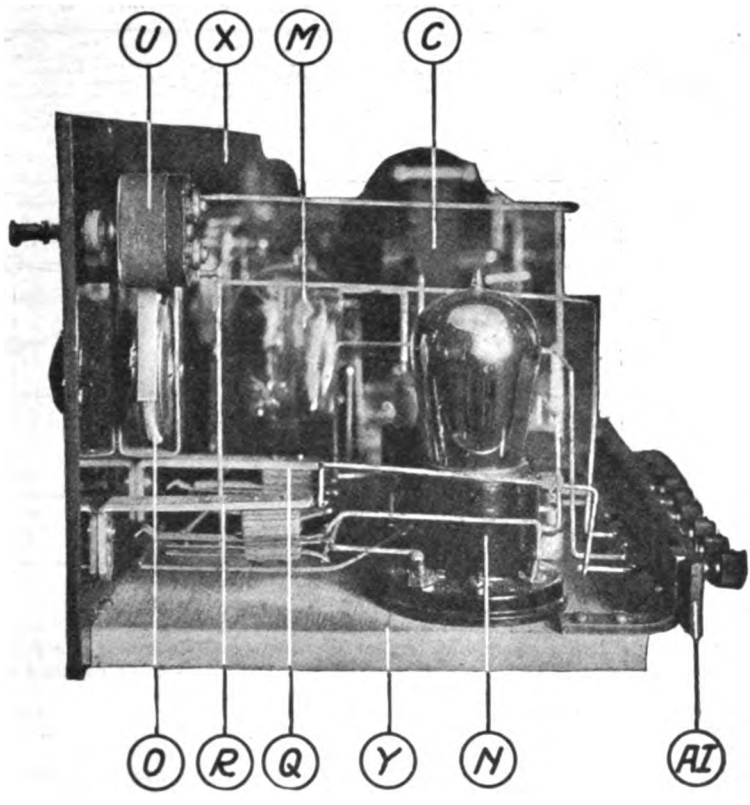

VIEW OF THE SET AS SEEN FROM THE RIGHT END

FIGURE 5: *This picture shows the way to mount the jacks, the tube sockets, the connection block, and the filament switch. The base is secured to the main panel with wood screws running through the panel into the edge of the wood.*

Wire the grid circuit of the second amplifier tube. This includes the secondary of transformer T, the grid terminal of socket N, the "C" battery and the negative "A" battery binding post (No. 3). The "C" battery terminals are soldered to the wires connecting it in the circuit in order to hold the battery in place.

Connect up the plate circuit of the last tube, consisting of the plate terminal of socket N, the jack R and the 112½-volt binding post, (No. 8).

Lastly, ground the negative filament lead and also the cores of the transformers S and T by putting a wire under the screws used to fasten the transformers down on the base.

How to Install the Set

After the set has been completely wired, place it in the cabinet and fasten it to the cabinet with wood screws through the panel.

The binding-post panel will now fit into the slot in the back of the cabinet and will come approximately flush with the back of the cabinet.

Attach the antenna to the first binding post at the right (looking at the rear of the set).

Connect the ground wire to the second binding post.

Connect the negative "A" battery wire to the third binding post.

Connect the positive "A" battery wire to the fourth binding post.

Preliminary to further connections, the "B" batteries should be connected in series to give a total of 112½ volts and with taps available at 22½ volts and 67½ volts. This combination may be conveniently made up of one 22½-volt and two 45-volt "B" batteries.

Connect the negative "B" battery terminal to the fifth binding post.

Connect the positive 22½-volt "B" battery tap to the sixth binding post.

Connect the positive 67½-volt "B" battery tap to the seventh binding post.

Connect the positive 112½-volt terminal of the "B" battery to the eighth binding post.

Insert one UV-200 or one C-300 vacuum tube in the detector socket L, and insert one UV-201-a or C-301-a tube in each of the remaining sockets K, M and N.

Plug in either the loudspeaker in jack R, or the telephones in jack Q.

Make certain the rheostats are turned off

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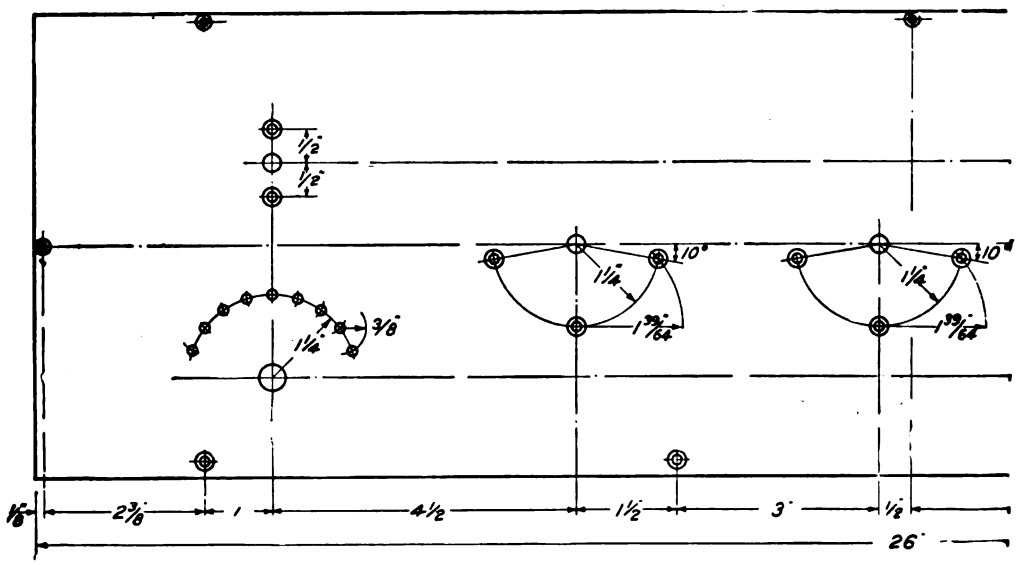
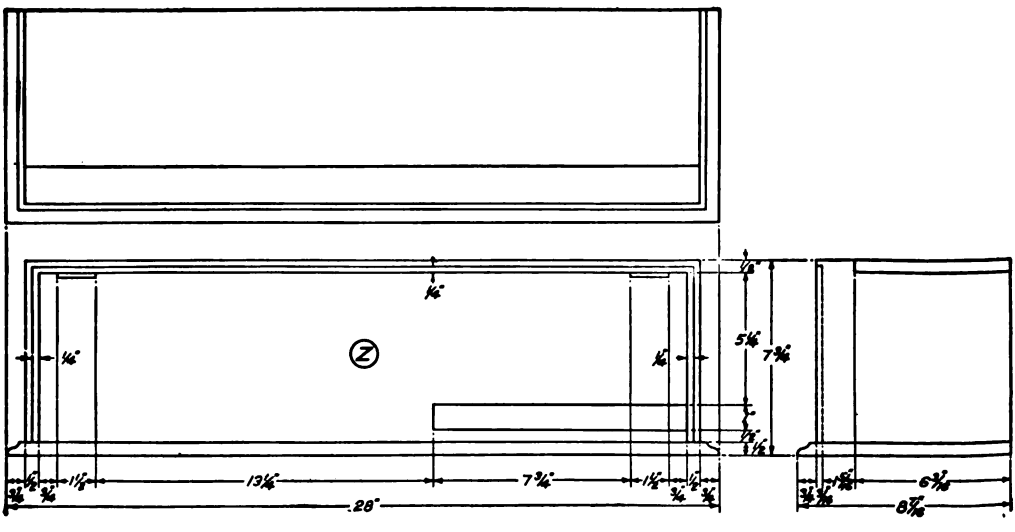


THE DRILLING PLAN FOR THE PANEL

FIGURE 6: *This drawing gives the correct dimensions for drilling the holes for mounting the instruments and also for the shaft holes. The holes outlined with a double circle should be countersunk.*



THE DIMENSIONS FOR THE CABINET

FIGURE 7: *This drawing, which shows the top, front and side measurements for the hardwood cabinet, may be turned over to a competent cabinet maker or the cabinet may be obtained direct from a manufacturer; it is a standard size.*

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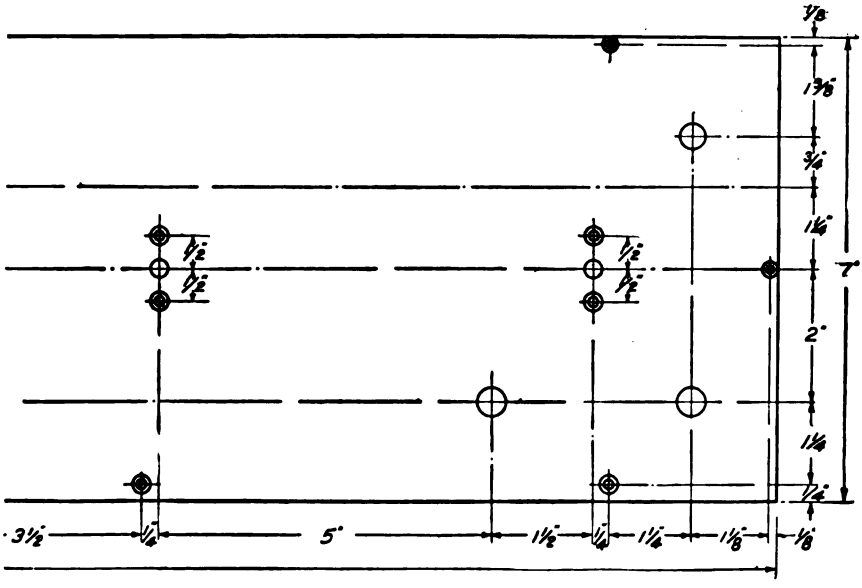

(to the counter-clockwise stop position), and then turn on the battery switch U by pulling the switch button out.

Gradually turn the rheostat P clockwise until the detector tube is burning with almost the same brilliancy as an ordinary tungsten electric light. Light the remaining bulbs by turning up rheostat O until they are burning with considerably less brilliancy than the old carbon style of electric light.

The condenser G can be set with about one-third of the set of rotor plates meshing between the stator plates for testing.

Set the tap switch V for a maximum number of turns in the antenna circuit, and set the coupling with the rotor coil about half way between the vertical and horizontal position.

Now, gradually rotate condensers E and F (keeping them at approximately equal settings) until a station is picked up. Remember that the tuning of condenser E is the sharpest and adjust it more carefully when searching for a station. After tuning in the signal to best advantage with condensers E and F, adjust tap switch V to the best point. This is the point with the smallest number of turns in the antenna circuit, consistent with loud reception. If too many turns are used in the antenna circuit the tuning of condenser E will be very broad. It will usually be found that, with any given antenna, there will be three or four switch points on which most of the tuning can be done.

After tuning in the loudest local station, the neutralizing condenser G may be adjusted permanently, and need be changed only when the radio-frequency amplifying tube in socket K is changed. To do this, remove the vacuum tube from socket K and wrap a piece of paper around one of the filament terminals; then replace the tube in its socket. The tube will not light now, and does not act as a radio-frequency amplifier. Any signals now audible are merely passing through the grid-to-plate capacity of the tube.

To reduce this signal strength to a minimum, start with the condenser G at zero capacity, (that is, with the rotary plates not meshed at all with the stationary) and gradually increase the capacity of condenser G, at the same time, adjusting condenser E for maximum signal strength with each change of condenser G. The signal strength will gradually decrease as the capacity of condenser G is increased, and the point at which the signal becomes inaudible or a minimum should be carefully noted.

Now, start with the condenser G at maximum capacity and gradually decrease the capacity, at the same time, adjusting condenser E for maximum signal strength as before. The signal strength will again gradually decrease as the capacity of the condenser G is decreased, and the point of zero or minimum signal strength should be again noted. With the aid of a good strong initial signal, these two points of zero signal strength may be made to approach each other within a very few degrees.

Set the neutralizing condenser permanently half way between the two zero points. If a louder signal is available later on, the neutralizing process may then be repeated more accurately, but generally one good test on a loud local station is sufficient.

Now remove the piece of paper from the filament terminal of the tube in socket K and replace the tube in its socket.

The set is now ready for permanent operation.

After tuning in a few stations in the manner described, the experimenter will become familiar with the degree of coupling to ob-

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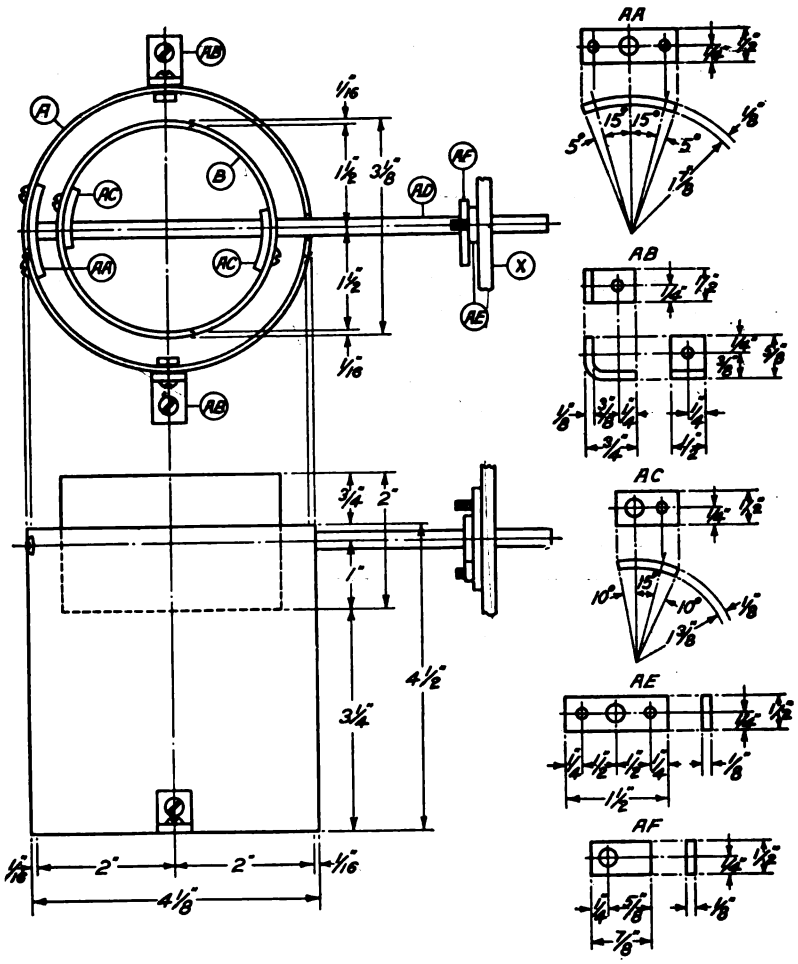

CONSTRUCTIONAL DATA FOR THE CRAIG COUPLER

FIGURE 8: *This drawing gives the specific details for the special coupler. The dimensions for all of the small brass parts are clearly shown, as well as the dimensions for the composition tubes.*

tain satisfactory selectivity, and also with which one of the switch points the tap switch V should be set on for a given wavelength range. The tuning will thereby be simplified and the sequence will probably be as follows:

Set the coupling as loose as you can, conveniently, for tuning.

Set primary-wavelength switch V on the correct tap for the wavelength you wish to receive.

Move condensers E and F (keeping each on approximately the same dial setting) until a signal is tuned in. Then adjust each of the two condensers until the signal strength is maximum.

The detector rheostat P should be operated below that point where a persistent hissing occurs. The amplifier rheostat O should be operated at the lowest point consistent with loud reception, that is, where turning the rheostat up higher does not give a noticeable increase in signal strength.

How to Make a Tuning Chart

First, make tests of several stations on different wavelengths and find the coupling value that you like best—taking into account both selectivity and signal strength. The chart will be made up for this one particular value of coupling and will not apply exactly to other coupling values.

Now, tune in as many stations as possible on different wavelengths and record the dial settings of condensers E and F, the setting of primary tap switch V and also the *known* wavelength of the station. Plot the dial set-

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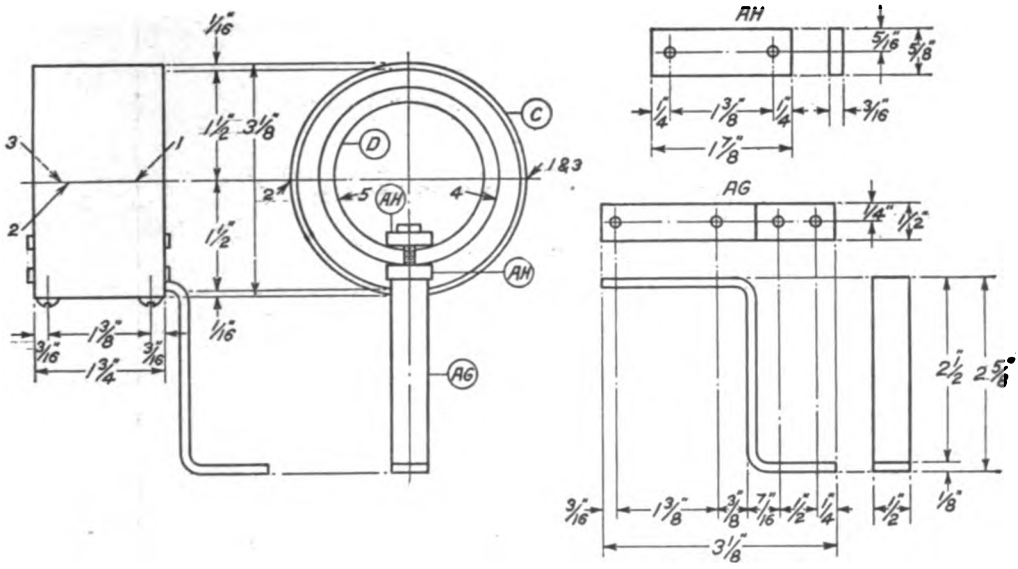
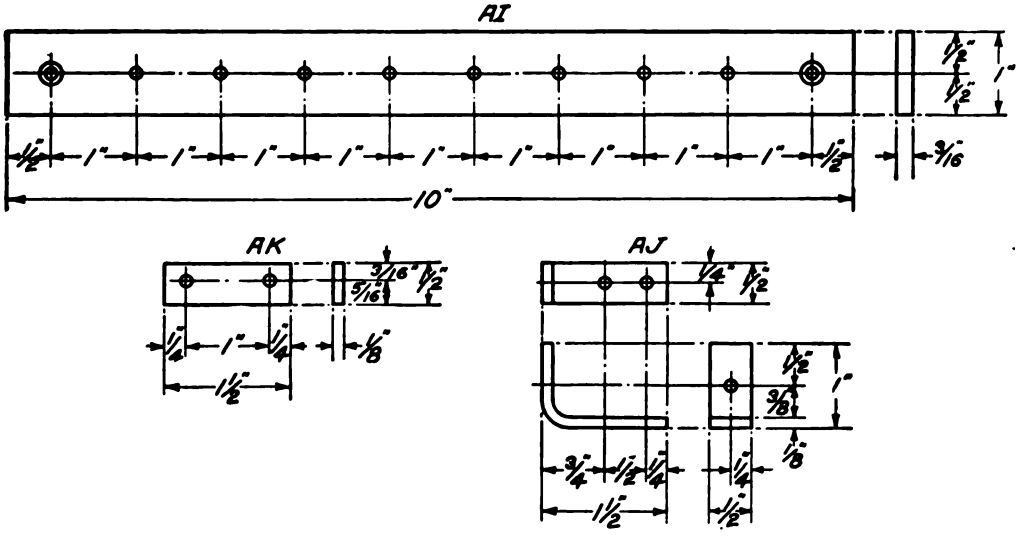


CONSTRUCTIONAL DATA FOR THE RADIO-FREQUENCY TRANSFORMER

FIGURE 9: *Here are given the dimensions of the tube for the primary winding, the brass supporting bracket and the small fastening blocks for the secondary coil. The arrows 1, 2, 3, 4 and 5 correspond with the numbers on the radio-frequency transformer in the wiring diagram (see Figure 1) and thus indicate the proper location for each connection to the transformer.*



THE CONNECTING BLOCK AND SMALL BRASS BRACKETS

FIGURE 10: *The block should be made as shown at AI. The brackets for mounting the block are shown at AJ, and the small pieces for mounting the neutralizing condenser are shown at AK.*

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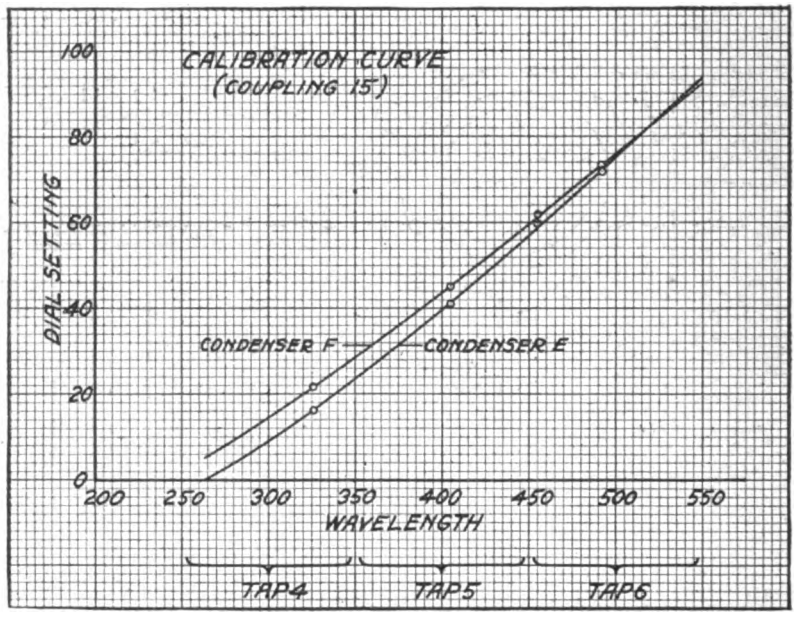

A SAMPLE TUNING CHART

FIGURE 11: *This chart was made by the author for use with a set coupling of 15 on the dial. Anyone can make a similar chart for his own set by recording both dial settings and the wavelength of several transmitting stations of various wavelengths. After these points have been plotted on cross section paper (as shown here), the points may be connected by a line which will give the settings for wavelengths that lie between the plotted points.*

ting of condenser E against the wavelength of the station, also plot the dial setting of condenser F against the wavelength of the station. Repeat the process for a number of stations and you will get sufficient points to enable you to draw a smooth curve for each condenser. A sample curve is shown in Figure 11. This chart shows how the experimental set tuned for four given stations. By inspecting your list of stations you can bracket the approximate wavelength range which each point on the primary tap switch V will cover.

With the aid of the chart just plotted you can now find the exact setting for the wavelength of any given station and can set all the tuning controls at the correct values to receive the station to best advantage. Of course, this chart assumes that the coupling *remains fixed,* at a predetermined value, but *so do all other* tuning charts. They are usually made up for receivers having fixed coupling.

Working Blueprints of This Receiver

IN order to accommodate readers who may desire actual-size diagrams of this simplified neutrodyne receiver, a set of three blueprints has been prepared, consisting of—

One panel pattern (actual size);
One instrument layout;
One picture diagram of all parts, showing the wiring.

This set of three prints will be forwarded, postage prepaid, upon receipt of $1.10.

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CONDUCTED BY DAVID LAY

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

A Record for Distance with Low Power

ACCORDING to an announcement by the American Radio Relay League, Mr. C. D. Maclurcan of Sidney, Australia, has succeeded in transmitting signals to New Zealand, a distance of 1,400 miles, with an antenna input of only .004 watt, which is far less than the power produced by a burning match. The power expended by an average man in getting up out of a chair would be enough to maintain radio communication at this rate, for about five minutes.

* * *

Air Police to Have Radio

THE seven airplanes belonging to the Police Department of New York City are being equipped with radio. The members of the aviation reserve attached to the Department are also receiving radio instruction.

* * *

Every State Now Has Broadcasting Stations

MISSISSIPPI was recently the only state in the Union that was without at least one broadcasting station. This distinction has now been relinquished, as a station has been installed at Coldwater, under the call letters KFNG. The wavelength is 254 meters. The station has already been heard in several states under its experimental call 5RK. One number sent out under this testing call was a series of negro spirituals sung by six negro farmhands. This was heard in forty-two states and in several provinces of Canada.

* * *

Exploring the Amazon by Radio

ANOTHER exploring expedition about to depart for an extensive investigation in the unknown lands and among the dangerous natives of the headwaters of the Amazon River, is to be equipped with a comprehensive radio outfit, not only for local communication between separate parties of explorers, but for continual communication with the outside world. The call assigned, temporarily, to the mobile station of the expedition is WJS. Arrangements will be made later for the assignment of calls by the Brazilian authorities. One of the subjects to be studied by the expedition is the nature and cause of the static so commonly reported from the forest-covered region through which the Amazon flows.

* * *

Will Radio "Kill" the Theatre?

WILLIAM A. BRADY, who knows the commercial side of the American theatre better, in all probability, than any other living man, is worried about radio. He thinks that it will make the theatre unnecessary—or, at least, that it will cut seriously into the theatrical receipts. Mr. Brady ought to know, but it is to be feared that he has been looking, for once, through bluer glasses than are necessary; the theatre has been threatened with death many times before.

* * *

Radio Communication for Railway Men

A NEW industrial use for radio has been announced by Sir Henry Thornton, president of the Canadian National Railways. It is proposed to install a company broadcasting station and to provide each employee with a radio receiving set, the company acting as purchasing agent to supply these sets at the lowest possible price. Then matters of interest to employees will be broadcast over the company station. It is hoped, says Sir Henry, that one result will be an increased solidarity of the entire company personnel.

* * *

Broadcasting Begins in China

ACCORDING to a report from the United States Consul, there are now two broadcasting stations on regular schedule in Hongkong, China. One has a 10-watt power, the other 100 watts. Who will be the first American listener to hear one of these stations?

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Radio Starts a Fire in Wet Wood

DURING some repairs recently at the great Leafield radio-telegraph station in England, a wooden partition about twelve feet from the tuning coil got wet. It promptly caught fire. The radio waves from the powerful transmitter were so strong that as soon as the dampness of the wood permitted their absorption by the partition, the heat produced was sufficient to ignite the wood. When powerful radio is around it is water that starts fires. Fortunately, no amateur transmitters are powerful enough.

* * *

Lightning Is Still Mysterious

WHEN he delivered, recently, the presidential address before the Institution of Electrical Engineers, Dr. Alexander Russell urged all scientific men to observe thunderstorms and record any peculiar appearances. This used to be done, he pointed out, before electricity was understood at all. The volumes of Transactions of the Royal Society of London a hundred or a hundred and fifty years ago contain many such records. When the laboratory forms of electricity came to be understood a little better, people lost interest in lightning. Really, however, we know very little about lightning, and the miscellaneous observations by people everywhere might prove very useful. Dr. Russell mentioned, especially, the appearance known as ball lightning or globe lightning. Few good observations of this have been recorded in scientific literature. If any of the readers of POPULAR RADIO have observed phenomena of interest in this connection the editor of this department will be glad to forward reports to Dr. Russell.

* * *

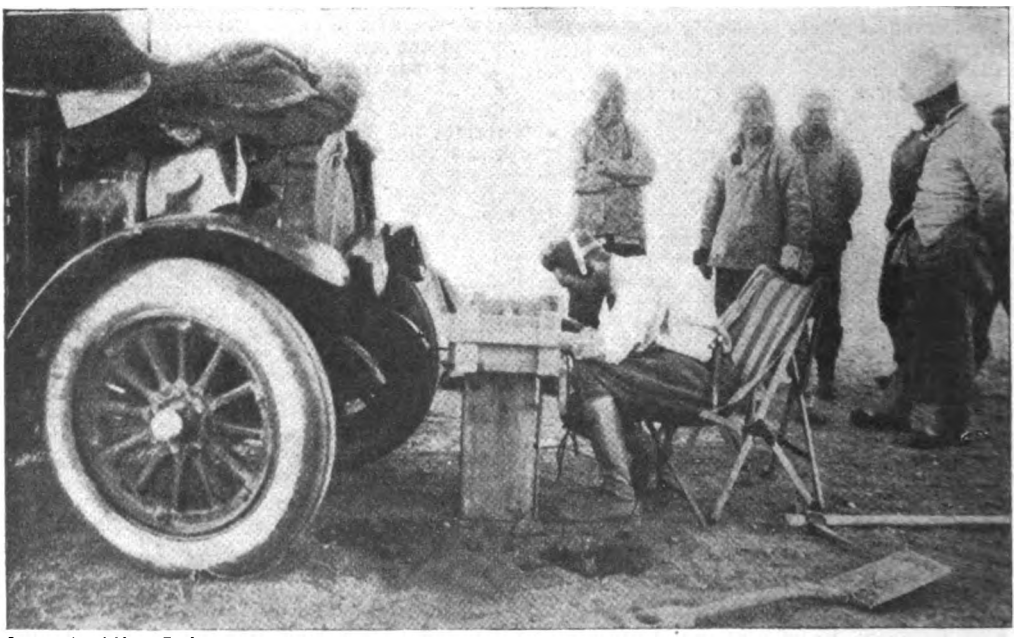
Radio Runs a Race Track

AT the race track at Grünwald, near Berlin, one of the most famous race tracks in Europe, radio sets have been installed recently for communication between the judges' stand and other parts of the track. The transmitters and receivers are adjustable to any wavelength between 200 and 1,000 meters. Some of the outfits are portable so that temporary stations can be set up anywhere in a short time.

* * *

Telegraphy of Pictures Is Now on a Commercial Basis

THE French government has announced that pictures will be received for transmission by telegraph over the French governmental wires between Paris and the cities of Lyons and Strassbourg. The fee charged figures out about seventy-five cents on the present rate of exchange. The process used is the familiar one of Belin. It ought to be worth while for some agency to offer a similar service in the United States, either by wire or by radio.



International News Reel

RADIO AIDS HUNT FOR DINOSAUR EGGS

On the recent geological expedition to Central Asia radio was used to get the exact time and thus to determine the exact position of the party from day to day. This expedition discovered the eggs of the great extinct reptile, the dinosaur—eggs believed to be more than 10,000,000 years old.

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Underwood & Underwood

A SOLEMN MOMENT IN THE ANNALS OF RADIO

So profound was the impression upon broadcast listeners of being actually present at the funeral services of ex-President Woodrow Wilson on February 6 that many knelt before the receiver during the prayer for the dead. This picture was made in a factory in New York.

Teaching Farming by Radio

In order to reach that part of the farm population which is unable to attend the courses at the university, the Kansas State Agricultural College is broadcasting, during the present winter, a complete course in scientific agriculture. Persons who take the course will be given certificates of graduation.

* * *

Cable Improvements Help Meet Radio Competition

One great difficulty of communication by submarine cables has always been the slow speed of the cable. Capacity effects between the conductor and the water outside, together with other electric difficulties, have limited the available speed to some twenty-five or thirty words a minute. So long as there was no competition, this was not so serious, but now, with transoceanic radio a more and more important factor, an increase of cable speed is desirable. It is announced now that it has been attained. The new metal, "permalloy," which is remarkable for its high magnetic permeability, has been applied to the construction of a cable which is said to have a possible speed of two hundred words a minute or even more. The details of the construction of the cable have not been made public.

* * *

A Broadcasting Station on Wheels

Station WTAT, owned by the company that supplies Boston with electric power and light, is built, complete, on a motor truck. The wavelength is 244 meters. The entire station may be moved about at a moment's notice so that broadcast programs can be sent out from any point without relaying the material.

* * *

A Radio Engineer Must Be Musician Too

At the Manchester (England) broadcasting station the control engineer at the modulation board has an orchestra score, just like the score that is before the conductor. The engineer can thus see what is coming in the music and get ready to increase or decrease the amplification, as may be necessary.

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Kadel & Herbert

RADIO ON A PERILOUS TRIP

Thousands of people in New York gasped with horror when they saw Bird Millman walk a tightrope strung between two cornices atop the 25th story of the Municipal Building. She carried a miniature receiver with her.

Radio in the Comic Strips

THERE are two ultimate awards of fame; one is to have a cigar named after you and the other is to break into the comic-strip cartoons of the daily papers. This last has come to radio in full measure in the past two months. A radio set is now as common a companion of Little Jeff, of Cicero Sapp and of all the others as the mislaid banana peel used to be.

* * *

Radio Dance Music in the Yukon

AT parties nowadays in the Yukon, says a newspaper dispatch from Dawson, men and women in evening clothes dance under pink-shaded lights to the music of famous orchestras from Chicago to San Francisco. Even the dance music from New York is occasionally received, all by radio.

Radio Fights the "White Plague"

"A RADIO set will do more to cure tuberculosis than any other apparatus yet devised." So says Dr. Walter K. Foley, of the Veterans' Hospital at Minneapolis, as quoted in a newspaper interview. The greatest obstacle to a cure, in tuberculosis cases, Dr. Foley says, is a worried and harassed state of mind on the part of the patient. A radio set gives the patient something to think about and takes his mind off his troubles. Then Nature completes the cure.

* * *

The Phonograph Industry Comes Around to Radio

NOT so long ago the phonograph industry was fighting radio, tooth and nail. It is different now. A recent issue of a prominent trade paper in the phonograph field contained, by actual count, as many radio items as all other items put together. One talking machine company is installing a broadcasting station and will soon use it to announce and advertise new records. Thus one of radio's erstwhile enemies becomes a friend.

* * *

A Scientist Who Speaks with His Hands

ONE of the modern scientists who has been studying the physics of speech, an investigation which has been of enormous value in the design of radio telephones and loudspeakers, is Sir Richard Paget. At a recent meeting of the Physical Society of London he demonstrated the skill he has acquired. Arranging his two hands in a box-like form to represent the resonance cavities of the mouth and throat, he blew into this hand-box the noise of a penny squeaker to represent the vocal cords. By manipulation of his hands he was able to pronounce several sentences clearly enough to be recognizable.

* * *

Radio Speech Over European Power Lines

ACCORDING to a recent note in the *Journal Télégraphique* (Berne, Switzerland) the principle of carrier-current telegraphy or "wired wireless" has been applied to communication by voice over power lines aggregating a length of 664 kilometers (413 miles) and with voltages ranging between 50,000 and 110,000 volts.

* * *

3,200 Radio Receivers in Denmark

A RECENT census of radio receivers in Denmark lists a total of 3,200. Nearly a fifth of these belong to students and as many more appear as in the hands of members of the engineering professions. Apparently radio has not yet spread to the Danish public, though regular broadcast concerts are available from the great Danish station at Lyngby as well as from the British, French and German stations.

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Atlantic and Pacific

HOW UNCLE SAM CHECKS UP ON RADIO BATTERIES

In this laboratory of the Bureau of Standards in Washington the commercial types of dry batteries for radio use are tested periodically for their voltage, amperage and hours of endurance under use. During the test the batteries are kept at constant temperature inside the glass-fronted case.

To Eliminate Interference

RADIO fans at Miami, Arizona, as well as at several other copper towns, have had much interference from the high-tension Cottrell apparatus used to collect dust and acid from the smoke of the smelters. The owners of the Miami installation, realizing the annoyance thus produced, have begun to rebuild the high-tension equipment so that as much of the static as possible will be grounded.

* * *

The Largest Hydro-electric Dynamo in the World

THERE has just been installed at Niagara Falls a new turbo-generator rated at 70,000 horsepower. This would be enough power to provide an amateur radio transmitter for every house in the United States.

* * *

Radio Supplants a Ship's Orchestra

THE steamship *Kroonland* of the International Mercantile Marine, now in passenger service between New York and California through the Panama Canal, has been equipped with loudspeakers so that broadcast concerts from American stations can be received during the entire trip. During pleasant evenings in the tropic waters, dancing on deck is possible to strains that originate in Chicago or Washington or New York.

* * *

A New Name for Radio Listeners

A PRIZE offered by *Popular Wireless* (London) for the best name to replace the English designation "Listener-in" has been awarded to the word "cohearer." Perhaps this is a delicate suggestion that all listeners ought to stick together.

* * *

Airplane Saved by Radio

THE value of radio installations on all passenger airplanes was demonstrated once more by a recent incident in Paris. An airplane had already left the Paris flying field bound for Geneva, Switzerland, when word was received at Paris that a violent storm was raging in the Swiss mountains. The radio operator at Paris immediately called the airplane pilot and instructed him to return to Paris, which he did.

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CONDUCTED BY LAURENCE M. COCKADAY

How to Use the Hartley Circuit for Reception

QUESTION: I would like to know if the Hartley circuit could be modified or arranged so that it could be used for reception? I am already using it for transmitting and I find that it reaches out so far that it makes me wonder what results could be obtained if its efficiency were to be the same for reception.

Can you give me a hook-up for such a receiver? I need just a single-tube circuit, as I have a separate two-stage, audio-frequency amplifier.

K. SMITH

ANSWER: The circuit you require is shown in Figure 1. This is not a special arrangement; it has been used considerably, and should give you fine results for reception.

The parts and instruments you will need are the following:

L1—primary winding of coupler;
L2—secondary winding of coupler;
VC1—variable condenser, .0005 mfd.;
VC2—variable condenser, .0005 mfd.;
GL—grid-leak, variable;
GC—mica fixed condenser, .00025 mfd.;
R—filament rheostat, 6 ohms;
Tel—telephones.

To make the coupler, wind (for the coil L1) 43 turns of No. 18 DSC wire on a composition tube 3½ inches in diameter. This coil should be tapped at the 3rd, 7th, 13th, 21st, 31st and 43rd turn.

Right next to this, wind the secondary coil L2. This is composed of 70 turns of the same kind of wire tapped at the 10th, 20th, 30th, 50th, 55th, 60th, 65th and 70th turn, starting from the top and looking at the coil as in the diagram.

The two sets of four taps each are hooked up as shown, with the ground wire connected to the 50th turn on the secondary winding.

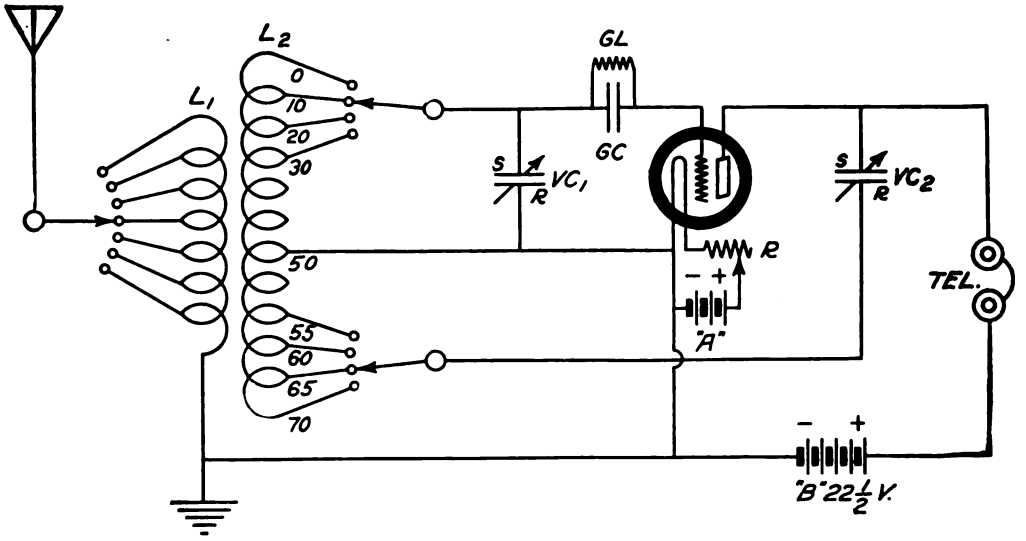

FIGURE 1: *A simple one-tube regenerative circuit that gives good results for the DX fan. The circuit is a modification of the Hartley oscillator.*

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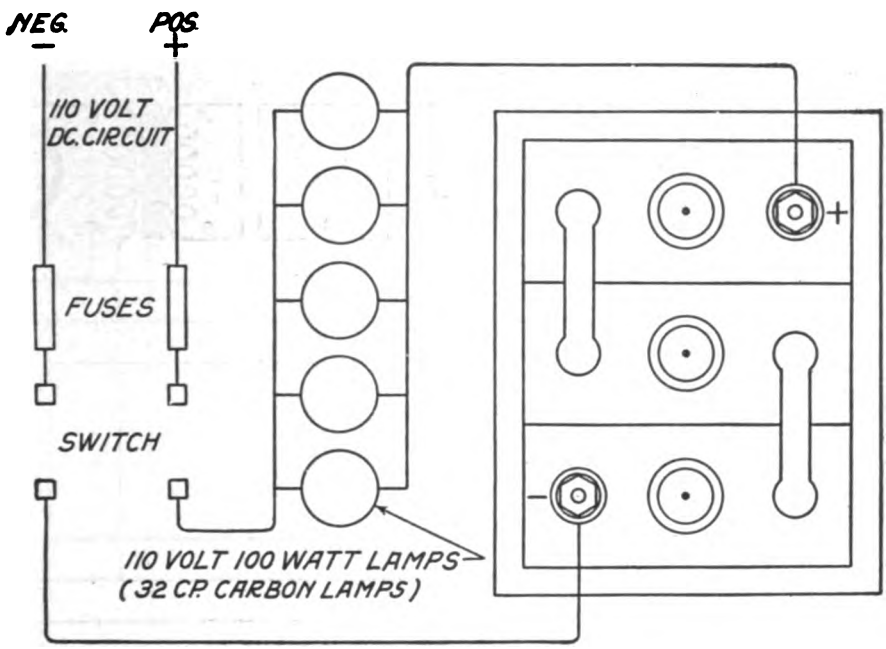

FIGURE 2: *This diagram illustrates the connections that should be used with a 110-volt D.C. lighting circuit through a bank of lamps. Be sure that the positive terminal of the lighting main is connected to the positive terminal of your battery.*

A Direct-current Battery Charger

QUESTION: I live in a vicinity where the lighting current is D.C., so that I am unable to use a regular battery charger. Will you please show me how to hook up some resistance lamps in series with the line so that it will be suitable for charging my battery? The battery is a 6-volt, 80 ampere-hour battery, and I have to take it to the garage about once in every three weeks for charging, and then I am out of commission for two or three days.

The lighting line that lights our house has a voltage of approximately 120 volts. HARRY E. RODNEY

ANSWER: The wiring diagram of the lamps and the battery circuit for charging is shown in Figure 2. By throwing the switch you charge the battery. You may use five 100-watt carbon lamps in parallel for the resistance bank. The whole lamp bank is connected in series with the line and the battery.

How to Run the Antenna Wires

QUESTION: I am situated alongside of a twenty-four-story building and I want to put up a radio receiving set. Would it be better for me to run a wire to the top of this building or out in some other direction? I have talked this over with some of my amateur friends and they seem to agree that it would work better if I keep it away from the tall building and run it to another lower building about 150 feet away across the courtyards.

I had always heard that it was better to get the antenna as high as possible.

So, I still think that the tall building would be the best to attach my wire to.

GEORGE H. MOORE

ANSWER: The single wire stretched across the court to the lower building would be our choice especially if the space directly underneath where the antenna wire would hang, were relatively clear of large objects.

The main objection to stretching a long vertical wire up the side of a tall building is that the building absorbs most of the antenna energy, and it never gets down to the receiving apparatus.

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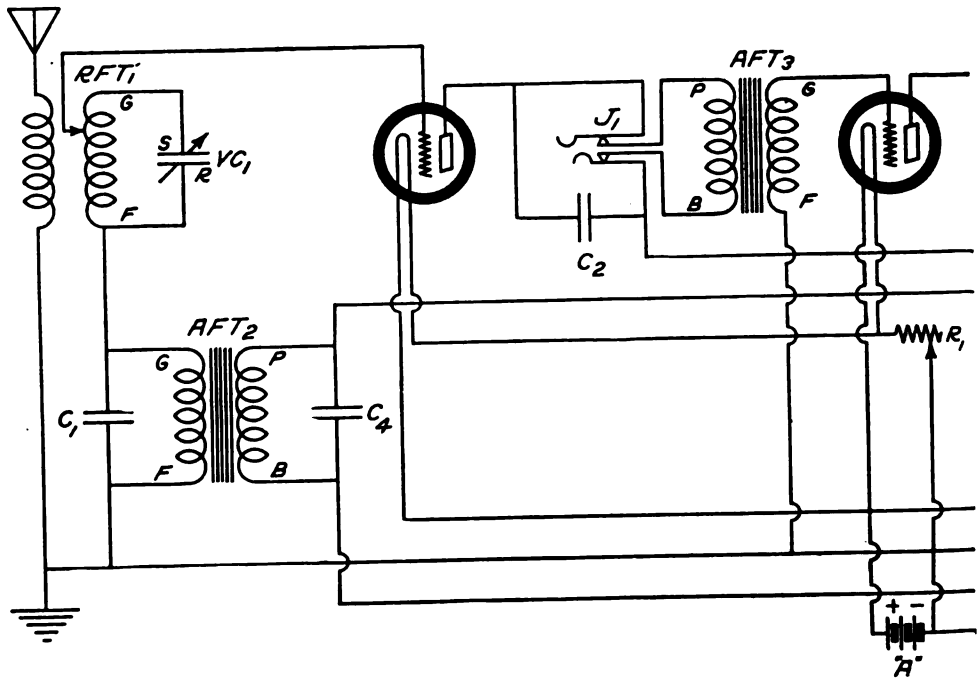

A New Reflex Circuit

QUESTION: Will you please let me know if there is any circuit that will allow me to use two stages of tuned-radio-frequency amplification, detector, and three stages of audio-frequency amplification, using vacuum tubes throughout?

I would like to use not more than five tubes if this is possible. Will you also give me the constants to use in the set and the parts that will be necessary to complete the set.

ALFRED JENNINGS

ANSWER: We recommend that you try the new reflex circuit that gives two stages of tuned-radio-frequency amplification, detector and three stages of audio-frequency amplification, with only four tubes.

We have drawn up the wiring diagram for this circuit in Figure 3.

The instruments and parts you will need for this hook-up are the following:

RFT1—neutroformer;
RFT2—neutroformer;
RFT3—straight radio-frequency. transformer;
AFT1, AFT2 and AFT3—audio-frequency transformers;
VC1 and VC2—variable condensers, .0005 mfd.;
C1—mica fixed condenser, .0025 mfd.;
C2—mica fixed condenser, .001 mfd.;
C3—mica fixed condenser, .001 mfd.;
C4—mica fixed condenser, .001 mfd.;
C5—mica fixed condenser, .001 mfd.;
R1 and R2—filament rheostats, 20 ohms;
R3—filament rheostat, 6 ohm;
GC—mica fixed condenser, .00025 mfd.;
GL—grid-leak, 2 megohms;
J1—telephone jack, double circuit;
J2—telephone jack, single circuit.

The first two and the last tubes may be either C-301-a tubes or UV-201-a tubes and the third tube may be either a C-300 tube or a UV-200 tube.

What Set Should I Build?

QUESTION: Which set would you advise me to build. I don't want to go over 5 or 6 tubes, but I want to get clarity, volume, distance and simplicity of tuning *with* selectivity. Is this possible to date? I want to make the set myself. Which one of the descriptions in your magazine should I follow to most nearly satisfy all of the conditions that I have outlined above?

ROBERT ECKHARDT

ANSWER: We advise you to build the improved 4-circuit tuner described in the January, 1924, issue of POPULAR RADIO. This will give you the results you want to get.

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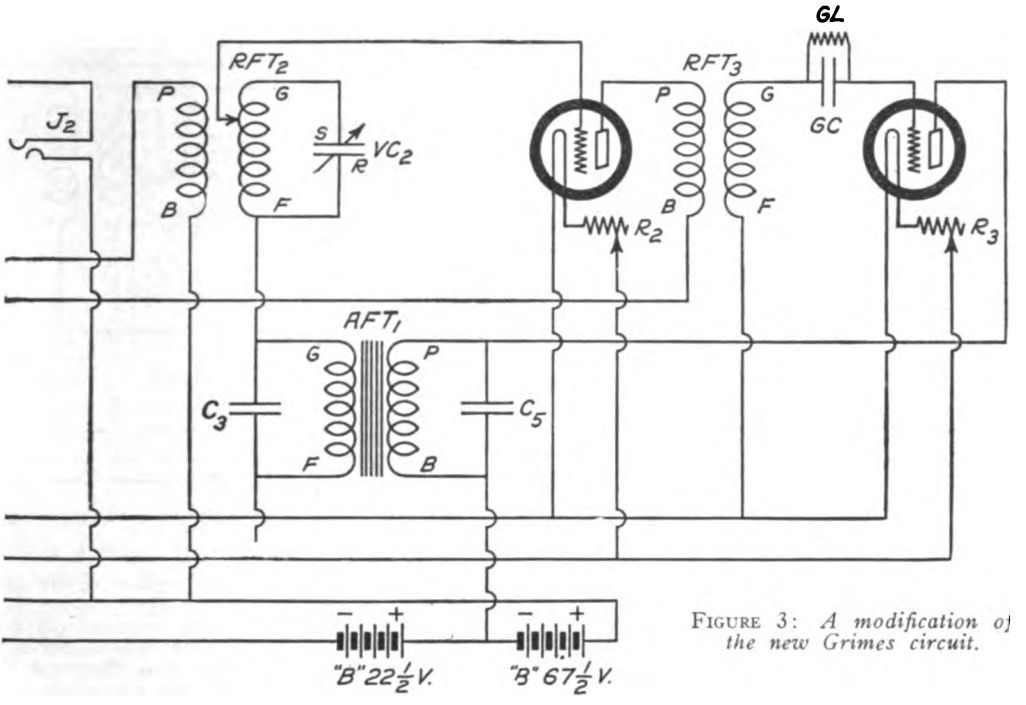

FIGURE 3: *A modification of the new Grimes circuit.*

Volume Control on a Power Amplifier

QUESTION: I have built the power amplifier described in the February issue of POPULAR RADIO, and I find that it allows me to get much better reception of distant signals on the loudspeaker, than I was able to get before on the headphones.

However, I find that the resistance control of volume does not allow me to cut down the signal strength of local signals sufficiently to make the music low enough for best enjoyment. Will you please tell me if there is any way to accomplish this by any other means?

JOS. ACKERMAN

ANSWER: You may make this control cover a greater range in volume by disconnecting the three resistances and the switch lever, and reconnecting them in the same manner across the two outside terminals of the secondary of the input push-and-pull transformer. This amounts to placing them across the secondary of the transformer instead of across the primary.

This change will allow you to reduce the strength of signal to a much lower value and will still give the same maximum on DX.

Where Can 50,000-ohm Resistances Be Obtained?

QUESTION: Can I use any other kind of resistances in place of the Lavite 48,000-ohm resistances? I find that it is next to impossible to get the Lavites in this part of the country. The dealers do not seem to have any knowledge of this accessory and are not sure what I ought to use instead of it.

K. F.

ANSWER: Any resistance unit of a value of approximately 50,000 ohms will be suitable for the volume control specified in the improved four-circuit tuner described in the January 1924 issue.

What is a Megohm?

QUESTION: What is meant by a 2-megohm grid-leak?

S. D.

ANSWER: A megohm is a unit of resistance. It is equal to one million (1,000,000) ohms. A 2-megohm grid-leak is a resistance of 2,000,000 ohms which is placed between the filament and the grid to allow excessive negative charges to leak off the grid so that the tube will *not* become inoperative.

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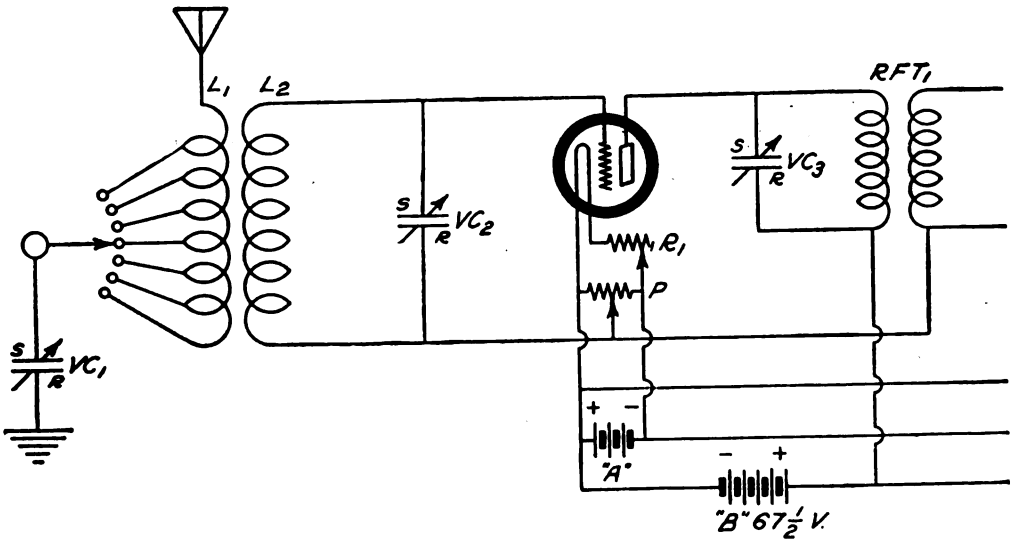

Radio-frequency Amplification with a Crystal

QUESTION: Please give me a diagram showing how to wire up two stages of radio-frequency amplification with a crystal detector. I have only two hard tubes and have been using them with the ordinary single-circuit regenerative tuner with one stage of audio-frequency amplification.

I am dissatisfied with the set, however, not because it could not reach out, but for two other reasons; it cannot tune sharply and I get a lot of interference. And also, as I have a number of other radio fans located in this same apartment house who are always complaining that my set "squeaks in their ears," I have determined to junk it and make another hook-up that will be good on distance but which will not re-radiate.

So, will you please help me out in my resolve and let me have a circuit that will give good distance on the headphones and yet will not require too much expensive apparatus. I haven't much to spend, that is why I started out with the single-circuit set; it was so reasonable in price.

CHAS. J. FINCH

ANSWER: You are doing a very wise thing and it will be to the benefit of all radio listeners in your vicinity, as well as, eventually, to yourself.

The circuit diagram you require will give you splendid results on distance and will cause no re-radiation. You find it in Figure 4.

The parts required are the following:

L1 and L2—primary and secondary coils of variocoupler;
VC1—variable condenser, .001 mfd.;
VC2, VC3, VC4, VC5, and VC6—variable condensers, .0005 mfd.;
P—potentiometer, 400 ohms;
R1 and R2—filament rheostats (to suit tubes used);
C—mica fixed condenser, .0005 mfd.;
Det—crystal detector;
Tel—telephones;
RFT1 and RFT2—two sets of two honeycomb coils mounted in double-coil mountings (four coils in all), two tube sockets.

This circuit met with great success in England in picking up American broadcasting during the tests of transoceanic reception that were held recently.

Cause of Fading

QUESTION: Why is it that stations from 200 to 300 miles away fade in and out regularly, and the same stations when heard from a greater distance do not fade to any extent.

I formerly lived in Clinton, Iowa, and experienced quite severe fading from the Chicago stations, while the eastern stations in Pittsburgh and Schenectady were exceptionally steady and regular.

I recently moved to New York and now I find that I get the Chicago sta-

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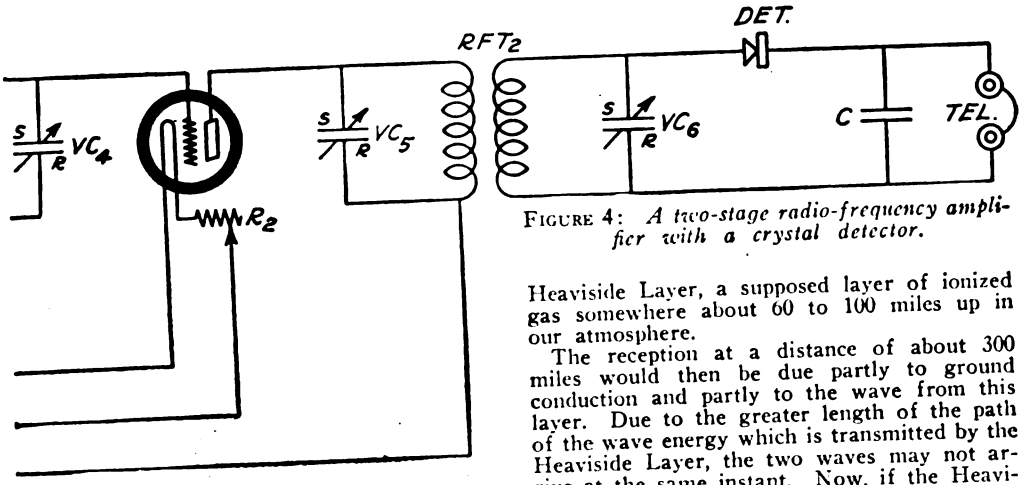

FIGURE 4: *A two-stage radio-frequency amplifier with a crystal detector.*

tions somewhat weaker but they are absolutely steady, whereas the stations of Pittsburgh and Schenectady seem to have become the worst "faders" that I now get.

This is not some particular freak of my location for I have asked other fans nearby and they tell me that KDKA and WGY always were the worst faders. Out in Clinton they are considered as the most regular and persistent stations in the east.

EDWARD AUSTIN

ANSWER: What you have recorded has been often brought to our attention before. It is a phenomenon which has only lately strengthened the theories of ground conduction of radio waves and the wave-carrying property of the Heaviside Layer.

These two theories have but lately been considered at loggerheads, some authorities claiming that one was correct and the other a fallacy and *vice-versa*.

The multitude of data on fading which have been collected through the aid of the broadcast listener have shed considerable light on the subject, and it seems to offer a substantiation of both theories.

By the new theory, which is a combination of the other two, the wave energy is conducted a short distance, say up to 500 miles, by ground conduction.

Local reception, then, would be due entirely to ground conduction. This may explain why local programs can be tuned in so readily by using a ground connection alone.

The reception from distant points is explained, under the new theory, as being largely due to passage of the radio wave along the Heaviside Layer, a supposed layer of ionized gas somewhere about 60 to 100 miles up in our atmosphere.

The reception at a distance of about 300 miles would then be due partly to ground conduction and partly to the wave from this layer. Due to the greater length of the path of the wave energy which is transmitted by the Heaviside Layer, the two waves may not arrive at the same instant. Now, if the Heaviside Layer is at all irregular, the path of the wave along it may vary in length. This would shift the time interval of arrival of the wave. The arrival of the wave energy from ground conduction would be constant as far as time is concerned.

Now, the theory goes on to state, if the arrival of a particular impulse by both paths is synchronous, the two would be added together in the receiver and for a short period the signals would be loud.

But if the formation of the Heaviside Layer should shift, so that the energy of a particular impulse arrived out of phase with the ground impulse, the two impulses would be subtracted in the receiver and the remainder would be all that is left to actuate the set. The received signals would then be weaker. The changes of the Heaviside Layer, then, explain fading at short distances because of a phase displacement of the wave along the layer as compared with the ground wave.

At greater distances where ground conduction has little or no part in the transmission it would not matter much whether the signal was slightly shifted in time arrival, for nearly the total energy would be received from the Heaviside Layer. The frequency would be so great that the difference in time arrival could not be noted.

Of What Metal is Bus-bar Wire Made?

QUESTION: What size square wire should I get to wire up my set in the "bus-bar" fashion? What kind of metal is it made of? I have seen some of it and it is silver colored.

WALTER D. GREEN

ANSWER: The wire you refer to is tinned-copper bus-wire, $\frac{1}{16}$-inch square.

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CONDUCTED BY RICHARD LORD

A limited number of questions of general scientific interest will be answered each month in this department. Readers are invited to send in questions that have puzzled them—but the selection of questions for answer cannot be guaranteed nor can questions outside the radio field be answered by mail.

Why are radio signals fainter just at sunrise and sunset than at other times?

THE only answer we can give is, that nobody really knows. This is still one of the many mysteries of radio. It is supposed to be related in some way to the fact that sunlight falling on the air improves its electrical conductivity so that the speed of radio waves is increased slightly. Just why this should affect transmission so greatly just at the beginning or end of the sunlight period we do not know.

What has happened when you "paralyze" a vacuum tube?

IN the normal operation of a vacuum tube the electrons from the filament accumulate to some extent on the grid, as well as on the plate. If the filament is burning very brightly, so that many electrons are being produced from it, the number of electrons hitting the grid may be so great that the grid wires acquire a considerable negative charge. This repels other electrons so that they cannot get through the grid to reach the plate. The tube stops working altogether. This is why a grid-leak is used. It lets the surplus electrons get away.

What are alpha, beta and gamma rays? Are they used in radio?

THEY are rays given out by radium and similar chemical elements the atoms of which are explosive. The names alpha, beta and gamma are merely the three first letters of the Greek alphabet. Alpha rays are really helium atoms shot out from the exploding atom of radium. Beta rays are electrons similarly shot out. Gamma rays are ether waves like X rays, but of shorter wavelength. None of these rays are used directly in radio, though the use of beta rays as a source of electrons in vacuum tubes has been proposed.

In making an ink line on paper for a grid-leak or other high resistance, why is it necessary to use India ink instead of ordinary ink?

BECAUSE the India ink consists really of very fine particles of carbon suspended in the liquid. The carbon is, of course, a conductor and permits a little current to pass. Ordinary ink does not contain carbon. It is a solution, usually, of aniline dyes. A line drawn with such aniline ink has no conducting properties.

Why does storage-battery fluid stain things so easily?

THE fluid in the ordinary lead-plate storage battery is dilute sulphuric acid. If you get this fluid on your clothes or on any other dyed article the acid will usually decompose the dye and change its color. On wooden articles the acid decomposes the wood and sets free carbon, which blackens it.

What is meant by "super-conductivity"?

WHEN some metals are cooled to extremely low temperatures, as, for example, by dipping them into liquid hydrogen, their conductivity for electricity increases very greatly. For example, at about 445 degrees below zero (Fahrenheit) lead has practically no resistance at all to the passage of an electric current. This is what is called super-conductivity.

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What is meant by "distortion" in a telephone or a loudspeaker?

ANY sound is really a vibration in the air or some other material and most sounds consist of a number of different vibrations going on at the same time. Each one of these vibrations has, of course, its own "frequency" or period of vibration. The human voice, for example, contains thousands of separate frequencies from the very low-pitched tones of the broad vowels to the very high pitches of such sounds as the hiss of the letter "S." A telephone (or other sound reproducer) is perfect only if it reproduces *all* of these thousands of frequencies. If any of the frequencies are suppressed or filtered out of the sound the emitted sound seems unnatural and is said to be "distorted."

What is the polarization of light? Is there any such thing in the case of radio waves also?

ORDINARY light consists of ether vibrations that move in every direction. If you think of the ether as having little particles in it, some of these particles would move up and down, some to the right and left, some in every possible direction in between. Polarized light differs from this. In it all the ether particles (if there were such things) would move in a single direction, say all of them up and down. Our eye cannot distinguish the difference between polarized and ordinary light, but there are various scientific instruments which can distinguish this difference easily. It is probable that something like polarization occurs in radio waves also, but it has not yet been detected.

Does the green color that forms on copper wires exposed to the weather decrease their electrical conductivity?

IF a green discoloration forms on copper wire it means that the wire is becoming corroded. The green material is copper carbonate or oxychloride. There is probably some acid or sea salt in the air. In itself, the green coating does not greatly affect the electrical properties of a continuous copper wire. But if the wire is joined as, for example, the wiring of a radio set or the connections of an antenna, the presence of green corrosion is a danger signal. The corrosion may penetrate the joints and destroy the electrical contact between the joined wires.

Is it possible to repair a storage battery that has been damaged by being "sulphated"?

IT is wiser, if possible, to return the battery to the maker for repairs, being careful, of course, to remove the acid before shipping the battery. If this is impossible, try the following procedure. First wash out the remaining acid with distilled water. Then add a solution of caustic soda in distilled water (about 4 or 5 percent of the soda) and charge the battery slowly until the positive plate has a pronounced chocolate color. Then wash out the soda solution, add acid as usual, and go ahead as if the battery were new. But do not be much disappointed if this procedure fails to work.

Why is it necessary to place an antenna at right angles to electric power wires that happen to be near it?

STRICTLY speaking it is not *necessary* to do this. It will merely give you less interference from the power wires. All power wires act, really, as a sort of transmitting antenna. Radio waves go out from them constantly, just as they do from a station that is broadcasting. If your antenna is parallel to the wires the waves from them will be picked up strongly and may make a disagreeable hum in your set. If your antenna is at right angles to the wires the waves from them will be picked up much less strongly and will probably not bother you.

Why do crystals "wear out" after a few weeks use so that you can no longer find a sensitive spot on them?

No one knows for a certainty but it is probably because a thin film of dirt or grease accumulates on the surface of the crystal. It is known, for example, that touching the surface of the crystal with the finger may destroy its activity, doubtless because of the tiny smudge of grease which the finger leaves behind. It is known, also, that an occasional washing of a crystal with pure ether or pure alcohol will frequently improve its activity. Most kinds of crystals should *not* be washed with water.

I notice on tracing out the wiring of my set that the circuit which includes the antenna and the ground does not seem to communicate at all with the other circuit in the set. Nevertheless the electricity seems to pass into the rest of the set somehow, for it works all right. How can this be?

THIS often puzzles beginners in radio. The circuits are *not* connected by actual wire, as door-bell or electric-light circuits are. The connection is through the ether. The electric impulses in the antenna-ground circuit set up ether waves around the wires and coils of that circuit. These ether waves pass across to the wiring of the other circuit of your set and produce corresponding electric impulses in it. It is a good deal the same thing, on a much smaller scale, as the fact that ether waves sent out from the broadcasting station affect your set at a distance, the only connection between them being through the ether.

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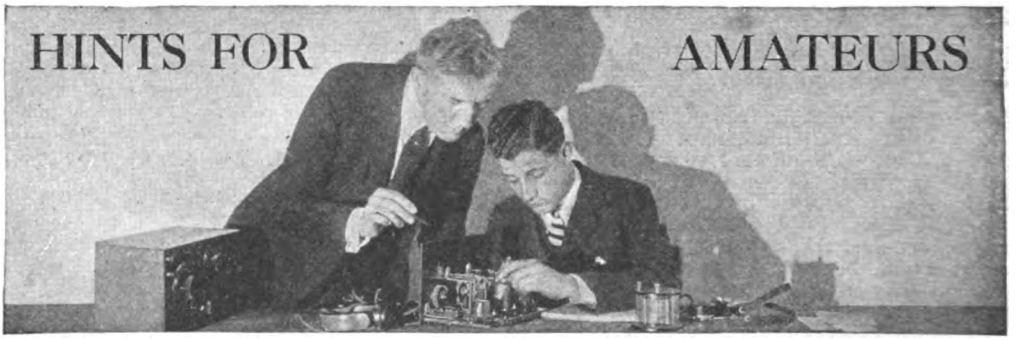

CONDUCTED BY ALBERT G. CRAIG

When Your Batteries Run Dry

WHEN your dry batteries have run down so far as to be useless, unscrew the small nuts that are used to fasten the wires to the terminals, before throwing the batteries away. These nuts or thumb-screws often come in handy just when you are looking for a nut and cannot find one: sometimes you lose a binding-post top and one of these meet the emergency.

Also when your "B" batteries go dead, take off the Fahnestock clips, they will come in handy when you least expect it.

A Short Cut in Wiring

THERE is a new accessory, just recently brought out, which should help the experimenter considerably in making a neat and efficient wiring job in a receiving set. This is a new combination of connection wire and insulation which is similar to a wire over which has been slipped a piece of "spaghetti." To wire up a set with this sort of wire all that is necessary is to cut the wire (with the insulation already upon it), bend it into shape and solder the ends.

This eliminates many of the operations necessary in using ordinary bus-wire and the varnished-cambric tubing.

Why Try for DX Reception?

THE most fascinating part of radio, for a while, is the reaching out for distance, the "DX bug" it is called.

But, for real enjoyment, sitting back in a comfortable chair and listening to a good local program, is the thing.

Where Haste Means Waste

DON'T get overenthusiastic, in laying out a new set, so that you rush some particular phase of the work or are tempted to put in some kind of make-shift part instead of waiting until you can obtain the correct one.

Go ahead thoroughly and build the set exactly as specified, carefully checking and rechecking your work and being sure of each step as you proceed. In this way you will be sure of success.

Beware of Power Lines!

DON'T run your antenna either over or under a power line. Either of them may break and fall across the other and cause you serious harm from electric shock, if you happen to be listening in at the time with the telephones on your ears. Keep the antenna wires well away from any power lines in your vicinity. This will also help you in obtaining clearer and louder reception.

Where the Whistling Comes From

DISCARD your single-circuit receiver and use one that will give you better tuning and greater sensitivity, to say nothing of elimination of re-radiation. The single-circuit receiver is the worst offender in producing those interfering whistles.

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A First-aid Kit for Your Receiver

A "FIRST-AID" kit for radio is pictured on this page. It is in use at the operating room at station WEAF. This is probably one of the reasons that this station is always on the job, with no serious "shutdowns."

The kit contains fuses of all descriptions and sizes, a screw-driver, pliers, wrenches, a circuit-testing outfit, etc.; all kept in a specific place.

The radio fan would not need exactly this kind of equipment but there is a helpful suggestion contained in the picture. It says: "If the fan would keep all his construction tools and materials on a kit-panel similar to the one shown, he would always know where to find his tools; they would always be accessible and in plain sight."

Most of the time spent in making a set, goes to looking for the tools: "Where is that screw-driver? Where did I put that drill? I can't find those 8-32 screws?"

Did you ever say anything similar to this?

A Tip on Antennas

AN outdoor antenna picks up many more times the energy than is picked up on an indoor antenna, a loop, or on a ground wire. Almost any kind of receiver will work on an outdoor antenna, several kinds of sets will operate on a short indoor antenna but few sets will work satisfactorily on a loop antenna.

A regenerative receiver sometimes works very satisfactorily on an indoor antenna or on the ground alone. It does not generally give the proper results on a loop.

A radio-frequency set will work on almost any kind of antenna if there are enough stages used and the same is true of the super-heterodyne.

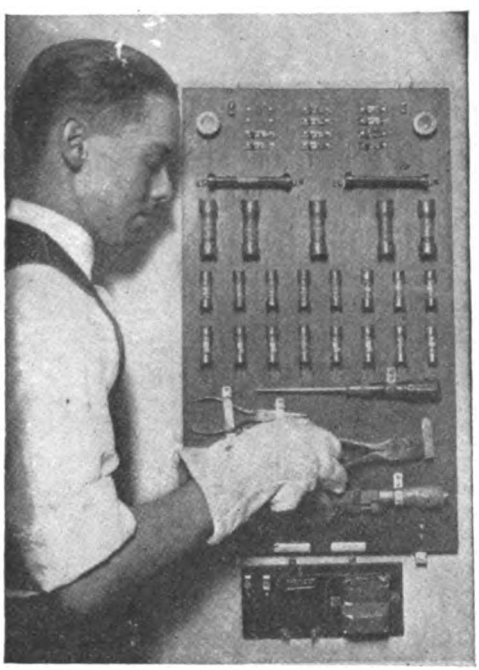
For all general purposes an outdoor antenna is desirable, especially where the reception of distant signals is a requisite.

Use the Tube That Is Specified

USE the tubes specified by the manufacturer or the designer of the receiver you are using. Don't expect to get as good results if you substitute some other kind of tubes.

Radio sets should be used with the proper tubes, just as automobiles should be used with the proper fuels and lubricants. You would not expect to get as good results with a gasoline car if you used kerosene in it. Of course, you might redesign the carburetor to take care of the change in fuel, and again, the radio set might be redesigned to work with another type of tube, but, do you *know* enough about the subject to do it?

This is the question you should ask yourself before you make any rash changes.



A first-aid panel that contains replacement fuses, screw-drivers, pliers and other necessary tools for repair work on a broadcasting transmitter.

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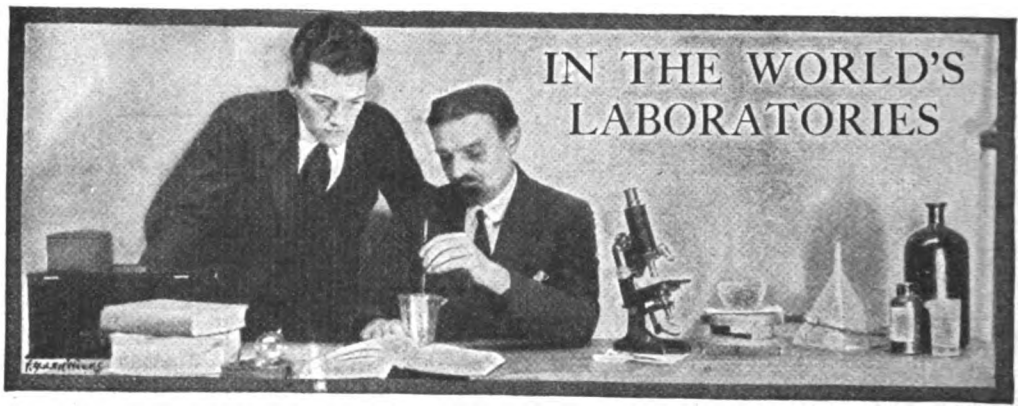

CONDUCTED BY DR. E. E. FREE

Getting a Sample of the Heaviside Layer by Rocket

ONE of the most interesting things that happened at the last meeting of the American Association for the Advancement of Science was a suggestion that came out in the course of the discussion of Professor R. H. Goddard's plan for a rocket powerful enough to escape from the earth's attraction and go off alone into space; the suggestion is that a rocket of this sort might be used to get real information about the Heaviside Layer.

In the last number of POPULAR RADIO were mentioned the recent theories of Dr. Vegard and of Professor Lindemann concerning the composition of this Layer.* Dr. Vegard believes that it is composed of solid particles of frozen nitrogen, a kind of nitrogen dust. Professor Lindemann prefers the idea that the Layer consists mainly of ozone. Other scientists incline to helium or hydrogen as the probable constituents of these uppermost levels of our atmosphere.

The best way to settle this argument, so important to the theory of radio, would be to get a sample of the Heaviside Layer and analyze the sample. This has always been considered impossible. The Heaviside Layer is supposed to be at least 50 miles above the earth's surface; some estimates place it as high as 200 miles. No balloon or airplane could hope to get as high as this; the present record, even for the small instrument-carrying balloons used by the Weather Bureau, being about 20 miles.

But the Goddard rocket has no such limitation. When loaded with a high explosive like smokeless powder, the rocket may be made to attain almost any speed, even, Professor Goddard believes, the speed of about six miles a second which the astronomers calculate to be sufficient for a body to escape altogether from the earth's attraction and never return. Certainly a speed sufficient to reach an altitude of 100 or 200 miles offers no insurmountable difficulty.

Public interest in this rocket scheme seems to have centered principally around the idea of sending a rocket to the moon. This would be spectacular but useless, as the rocket could not come back. We would never even know that it had arrived. How much more useful to send up a rocket to bring back the much-desired sample of the Heaviside Layer!

A rocket could be built, Professor Goddard claims, to carry recording apparatus that would give a continuous record of the air pressure, of the electrical constants of the air, of the degree of ionization, even of the amounts of radiation of different kinds received from the sun at each mile of elevation. There could be, also, an apparatus which would automatically seal in and bring down to us a sample of the material; nitrogen dust or ozone or helium gas or whatever it really is, that constitutes the atmosphere at the highest point reached.

A telescope trained on the rocket as it rose would give us the constants of its flight and enable the prediction of its probable place of return. A parachute would bring it down safely and some kind of automatic signal would announce its return and enable the waiting scientists to find it immediately and to recover for laboratory examination the precious freight of scientific records and samples that it would bring back to us. It might be possible, even, to have the rocket report by radio each second during its flight.

Professor Goddard is a scientist of distinction. His plans are said to have the approval of the American Association, of the Smithsonian Institution and of the National Research Council. The proposition is no cracked-brained scheme of a fanatic, but is a serious and practicable scientific project. It is said that the only difficulty is funds; the sum of $5,000 has been mentioned. This seems small to stand in the way of so important a research but it must be remembered that scientific institutions are never rich.

Any radio fan who can afford to spend a few thousands for the benefit of radio science cannot do better than write to Clark University and get in touch with Professor Goddard.

* "Dust in the Earth's Attic," POPULAR RADIO, vol. 5, page 299 (March, 1924).

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Everything You Need to Know About Vacuum Tubes

THE vacuum tube has become of so much importance in all kinds of scientific investigations as well as in radio that the National Research Council arranged some time ago for the preparation of a treatise on the properties and uses of this extraordinarily useful new device. The result, from the pen of Mr. Robert W. King,* has now appeared as a separate publication, in advance of the complete manual contemplated by the Council and which is to include accounts of other research instruments and methods as well as of the vacuum tube.

The report is a comprehensive and clear summary of all the important properties and uses of vacuum tubes. The characteristics of tubes are discussed, with examples; as are also the use of the tubes as amplifiers, modulators and detectors; the construction and properties of vacuum-tube oscillator circuits, and a number of minor uses of tubes, such, for example, as their employment in safety devices for power circuits and in the ionization manometer for the measurement of very small gas pressures.

The paper is itself a summary and is adequately condensed. It is useless, therefore, to attempt to summarize it further. Every radio engineer should own a copy of it, and both Mr. King and the National Research Council are to be congratulated on making it available to the radio public.

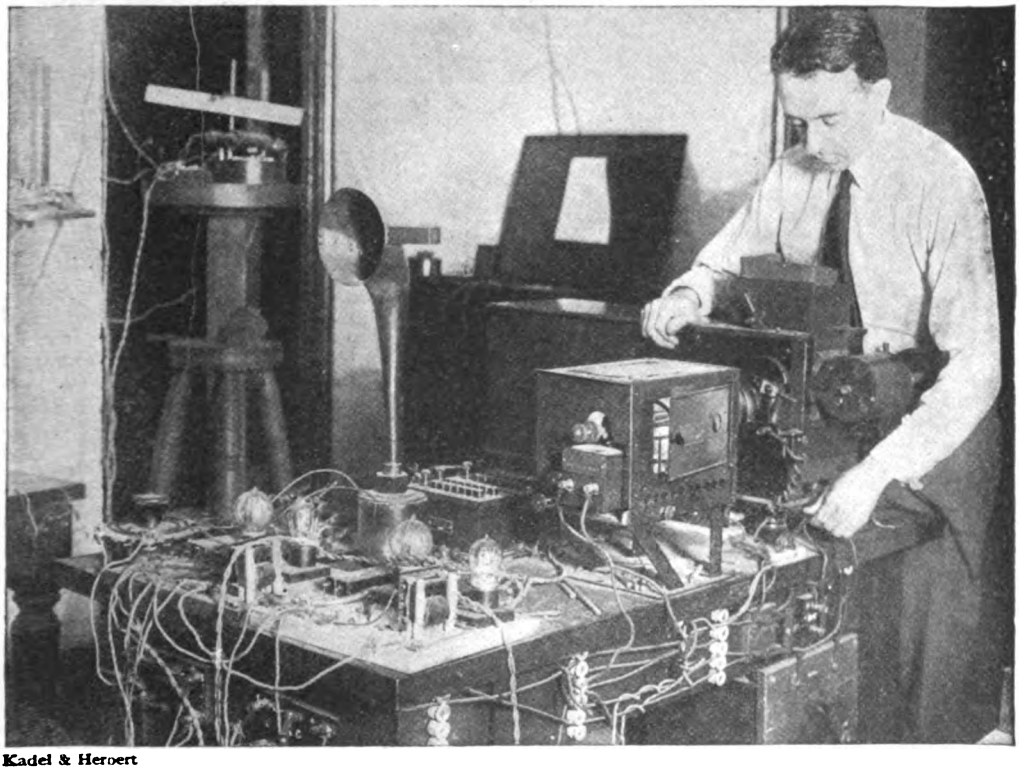
* "Thermionic Vacuum Tubes and Their Applications," by Robert W. King. *The Bell System Technical Journal*, vol. 2, pages 31-100 (Oct., 1923).

Does Bad Iron Inside the Earth Help to Cause Fading?

EVERY radio amateur knows that bad iron in the cores of his transformers will make trouble. If the magnetic properties of the cores are uneven or variable the transformers will not behave properly.

Possibly something of the same sort is going on inside the earth. The suggestion is made by Mr. F. Kiebitz, an engineer of the German Governmental Telegraph Service, in a recent article on the transmission of waves used for radio telegraphy.*

* "Propagation Phenomena and Disturbances of Reception in Spark Telegraphy," by F. Kiebitz, *Jahrbuch der drahtlosen Telegraphie und Telephonie* (Berlin), vol. 22, pages 196-203 (November, 1923).



Kadel & Herbert

TAKING THE BERTILLON MEASUREMENTS OF A VACUUM TUBE

Each type of vacuum tube has its own special characteristics, as definitely its own as are the measurements of a criminal. To determine these characteristics the oscillograph is used; this instrument is here shown in operation in the hands of Mr. J. C. Aceves of Columbia University.

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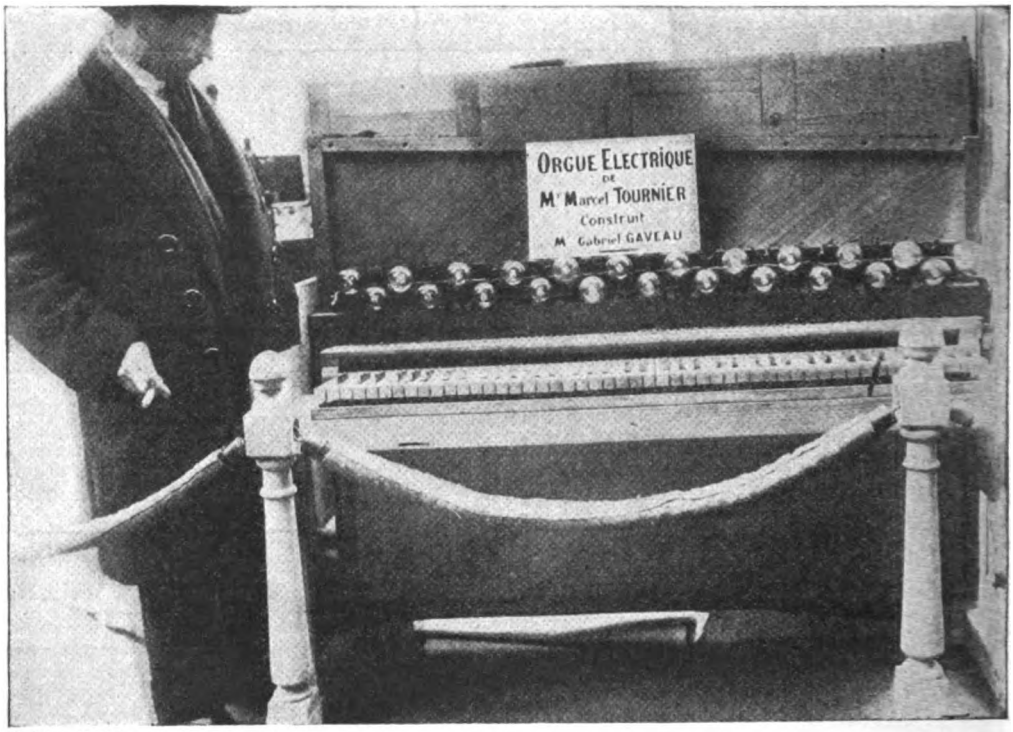

Kadel & Herbert

THE NEW ORGAN BUILT OF VACUUM TUBES

This novel musical instrument, exhibited recently at a radio exposition in Paris, produces music from vacuum tubes, after the manner described by Dr. Lee De Forest in POPULAR RADIO *back in November, 1922. Each tube is tuned to give a definite musical note. The keyboard operates these tubes just as an organ keyboard operates the reeds or pipes of the organ.*

It is known, says Mr. Kiebitz, that the earth has an iron core. Electric currents and electric charges exist in the atmosphere and in the part of the earth that we call the crust, which surrounds the iron core. We live on the surface of a globe that may be considered, from the electrical standpoint, as a vast iron-core transformer the core of which has been made, not of carefully selected iron as the cores of radio transformers are, but of any old iron that happened to be about. We do not even know what kind of iron it is.

From his own studies as well as from the numerous investigations of other engineers, Mr. Kiebitz concludes that many of the disturbances shown by long-distance radio waves must originate in some world-wide cause; presumably some disturbance in the atmosphere, in cosmic spaces outside the earth, or, he adds, in the earth's interior. This third possibility does not seem to have been considered sufficiently by radio engineers. It is known that many varieties of iron, when placed in a variable magnetic field, do not respond to the field in accordance with any simple law. Both the magnetization of the iron by the field and the reverse action of the iron in modifying the field are quite complicated.

"The earth possesses," Mr. Kiebitz continues, "a magnetic field which experiences continual changes. Masses of iron in the earth's interior or in the crust will suffer, therefore, continual alterations of their magnetism. We do not know much about the iron masses of the earth, but by a study of those electromagnetic disturbances which occur simultaneously over a large part of the earth's surface, we ought to be able to discover whether or not these disturbances may be due to magnetic reactions in, or from, the iron parts of the earth's interior."

Measuring Starlight with a Radio Amplifier

THE latest achievement of General Ferrié, the distinguished head of the Communication Service of the French Army, in his experiments on the scientific uses of radio is the measurement of the light that comes to us from a single star.* Faint as is this tiny ray it will

*"The Amplificatoin of the Current from Photo-electric Cells and Its Applications," by G. Ferrié, R. Jouaust and R. Mesny. *Comptes Rendus de la Academie des Sciences* (Paris), vol. 177, pages 847-849 (Nov. 5, 1923).

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affect very feebly the emission of electrons from a tiny plate of metallic potassium in a vacuum. Such a plate constitutes the most delicate kind of photo-electric cell. When the ray of starlight enters such a cell it causes a tiny electric current.

General Ferrié's apparatus for the amplification of this feeble current involves a special design of vacuum tube the grid of which has a very low capacity, and also an arrangement by which a rotating split-disk alternately cuts off and lets through the light from the star. These interruptions of the light produce an audio-frequency note in the photo-electric cell circuit. The impulses are then fed into a train consisting of an audio-frequency transformer, three amplifier tubes, a modulator tube and a final amplifier tube. The result is an amplification (in terms of energy) of more than a million times.

A Gas Flame as an Amplifier

THE fact that flames contain free electrons is well known to all radio experimenters. According to the familiar story, it was this fact that led De Forest to the invention of the three-element vacuum tube.

The fact has now been applied by Dr. E. V. Appleton to the construction of an amplifier which is novel and which will appeal to many amateurs whose minds have an experimental twist.* The usual three electrodes of a vacuum tube are inserted in the flame of a gas burner of the type used by chemists and called a Bunsen burner.

The electrode corresponding to the plate is a straight wire of platinum or other refractory metal inserted in the lower part of the flame. The filament electrode is another wire, the tip of which is bent vertically upward. The grid is a small wire spiral surrounding the filament electrode. A little sealing wax applied to the tip of the filament wire and allowed to burn off increases the number of electrons in the flame and betters the operation of the device.

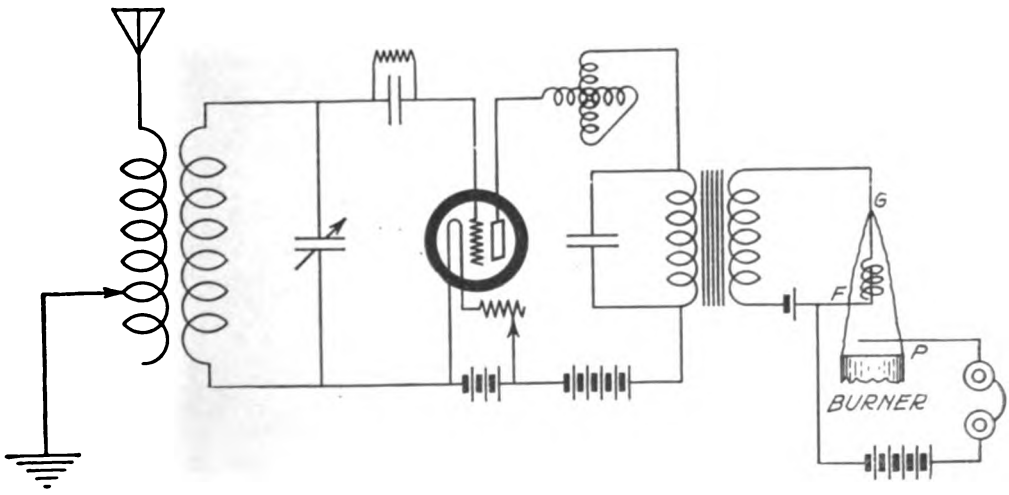
This arrangement behaves, says Dr. Appleton, much as does an ordinary amplifying tube except that the electrons in the flame are fewer and accordingly the maximum filament-to-plate current is less. The number of electrons can be increased, however, by feeding certain materials, for example sodium, into the flame. The device is not a present rival of the vacuum tube but experimentation with it has interesting possibilities.

* "A Novel Amplifier," by E. V. Appleton, *Popular Wireless*, vol. 4, page 559 (December 8, 1923).

Will We Have the Radio Phonograph?

A POSSIBLE new application of radio has been suggested by a French radio engineer, Mr. E. Pepinster, in the form of a revival of the well-known but commercially unsuccessful invention of the telegraphone.* This instrument, invented years ago by the famous Danish engineer Poulsen, was a device for recording speech or other sounds by means of a magnetic record made on a wire of steel or iron running between two spools. It proved in practice to be less satisfactory than the familiar mechanical phonographs in which the record of the sound is made in the form of minute indentations in

* "The Phonograph of the Future," by E. Pepinster. *Radio-Électricité* (Paris), vol. 4, pages 475-476 (Nov. 1, 1923).



THE HOOK-UP FOR THE GAS-FLAME AMPLIFIER

This shows how the flame of a Bunsen burner may be connected to a standard radio circuit. The flame is shown at the right. The platinum spiral G operates as the grid. The bent wire F is the filament and the straight wire P takes the place of the plate.

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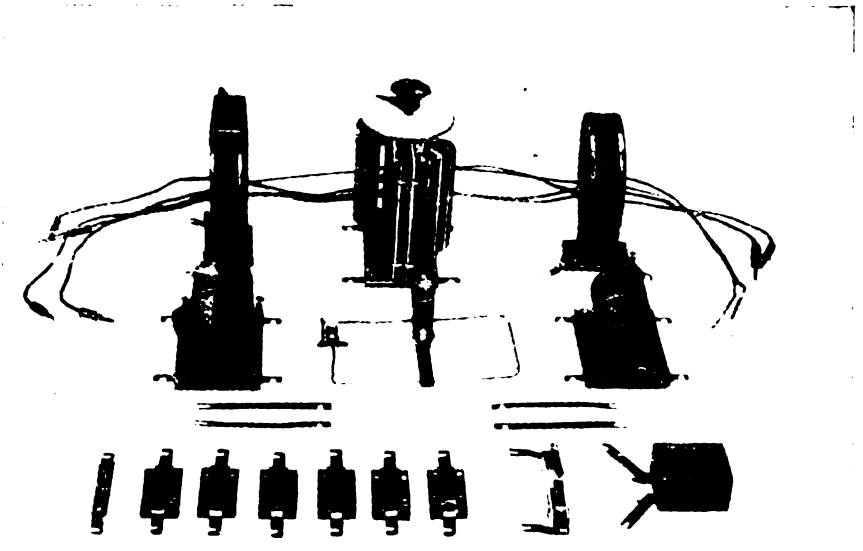
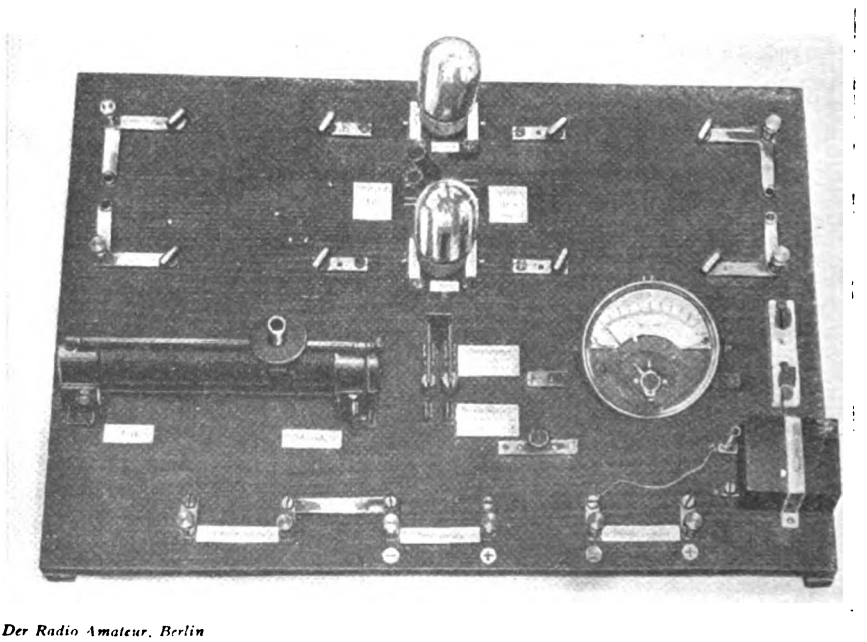


Der Radio Amateur, Berlin

A GERMAN DESIGN FOR A UNIVERSAL RADIO TESTING BOARD

These coils, variometer, transformers and condensers are equipped with metal lugs that fit the gaps between binding posts on the board shown below. It is easy to hook these lugs under the posts and thus insert into the circuits on the board whatever coil or other instrument you want to use.



Der Radio Amateur, Berlin

THE FIXED PART OF THE GERMAN TESTING BOARD

The two tube sockets, the sliding resistance and the milli-ammeter are fixed permanently to the board, together with the binding posts for attachment of the interchangeable instruments shown above. The binding posts at the bottom of the board are for the attachment of the battery leads.

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the bottom of a groove on a disk or cylinder

When the telegraphone was new and on trial there was no such thing as a vacuum-tube amplifier. If there had been, says Mr. Pepinster, the Poulsen device might have proved more successful than it did. He suggests that the telegraphone principle, combined with modern amplifiers both for recording and for reproducing, deserves a new trial.

That American inventors are working along a somewhat similar line is evidenced by the patents of Carlson and Hanson noted in the "With the Inventors" Department in POPULAR RADIO for March. But these patents do not contemplate, apparently, the use of the telegraphone as a substitute for the phonograph. That is just what Mr. Pepinster does contemplate. It may be, he thinks, that the helping hand of radio will enable this old invention to do just what its inventor hoped, that is to displace the disk phonograph from popular favor.

Catching Salt Molecules with a Vacuum Tube

THE vacuum tube is invading the chemical laboratory. Scientists at the Worcester Polytechnic Institute had need recently of a very delicate method for measuring the exact amount of common salt in very weak solutions, solutions containing only about one part of salt in some 40,000 parts of the solution. The ordinary chemical methods were not sufficiently precise for this. The molecules were too few to be caught.

It occurred to someone to use a vacuum-tube amplifier. It was tried. It worked, and added to the resources of the analytical chemist one of the most accurate and delicate tools yet discovered in this field.* The tube is used to amplify and thus to indicate on a galvanometer the very slight change of electro-chemical condition in the solution that occurs as the small trace of salt in it combines with a known solution of silver chloride added drop by drop.

It is predicted that this way of following the progress of a chemical reaction is likely to prove useful in many chemical processes, not only in laboratory work but in the larger-scale operations of chemical plants. The wonder-working tube will soon be, we predict, as common in industry as the thermometer and the pressure gauge are now

A Universal Radio Set for Trying Out New Hook-ups

So many new circuits and modifications of old circuits are proposed each month that the experimenter who wishes to try all of them finds it increasingly convenient to provide himself with a universal receiver mounting that can be re-connected quickly and easily to fit almost any possible combination of circuits.

One mounting of this kind that seems more convenient than most is described in a recent article by Paul Oard*. It consists of one vario-coupler, two variometers, two variable condensers, one three-honeycomb-coil mounting, three tube sockets, one potentiometer, one rheostat and one unit consisting of a detector and two stages of audio-frequency amplification. All these instruments are mounted firmly on a base-board, sufficient space being left between the instruments to permit wires to be run from one to the other in any desired way. There is sufficient space, also, to permit the insertion of fixed condensers, grid-leaks, and other small accessories, wherever desired.

To test out a new circuit with this board all that is necessary is to run bus-wire or flexible connectors between the proper terminals. There is no need to hunt up apparatus, figure out how to place it and then mount it on a panel, only to tear it all down again as soon as the test has been made.

While other experimenters may desire to add additional instruments to the ones used by Mr. Oard, or to modify his selection in other ways, the general idea of a universal test board flexible enough to permit the quick and convenient assembly of almost any radio circuit is one that will appeal to every amateur who likes to try out things for himself.

Broadcasting Lengthens Its Ear

THE ear of the broadcasting station is its microphone. The transmitter can send out only what the microphone can hear. That is why so large a proportion of the programs that are broadcast originate right in the studio of the station, where "mike" is most perfectly at home.

But there has arisen, more and more, a demand for a microphone that can leave home occasionally and go off on short notice to any theatre or concert hall or church where some material worth broadcasting is to be picked up. This demand has now been met by the portable radio-relay equipment devised and used at station WGY at Schenectady, New York. A small portable transmitter has been mounted on an automobile. This can be sent anywhere quickly and the microphone attached to it can pick up any available material. Then, the portable transmitter sends this material, on a short wavelength, the necessary two or three miles to the main station of WGY. There it is picked up by a receiver, translated to the regular WGY wavelength and re-broadcast to the station's listeners.

The advantages of this system are that it does away with the necessity of telephone wires between the broadcasting station and the outside locations of its microphones. Such wires are not always to be had conveniently and they introduce, also, some well-known electrical

*D. F. Calhane and R. E. Cushing, "An Application of the Vacuum Tube to Chemistry," *Industrial and Engineering Chemistry*, Vol. 15, pages 1118-1120 (November, 1923).

*"A Radio-circuit Testing Board," by Paul Oard, *Radio* (San Francisco), vol. 6, page 18 (January, 1924).

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troubles in the way of distortion. Eighteen months ago when POPULAR RADIO arranged the first broadcasting of the Lewisohn Stadium Concerts in New York one of the chief difficulties was that of obtaining a satisfactory telephone line from the Stadium in upper New York City to station WJZ, then located in Newark, New Jersey.

The new system does away with all this wire trouble and we may be sure that it will spread. Indeed a similar experiment is reported in London, where programs from the Old Vic Theatre are now being sent by a short-wave transmitter installed at the theatre to a receiver at 2LO, from which station they are re-broadcast to the country.

Pulling Electrons Out of Metal with 200,000 Volts

THE escape of electrons from a heated filament, which constitutes the source of electrons in all vacuum-tube devices, is something which ought to take place, in some degree, even at lower temperatures. The heating of the filament merely facilitates the escape of the electrons.

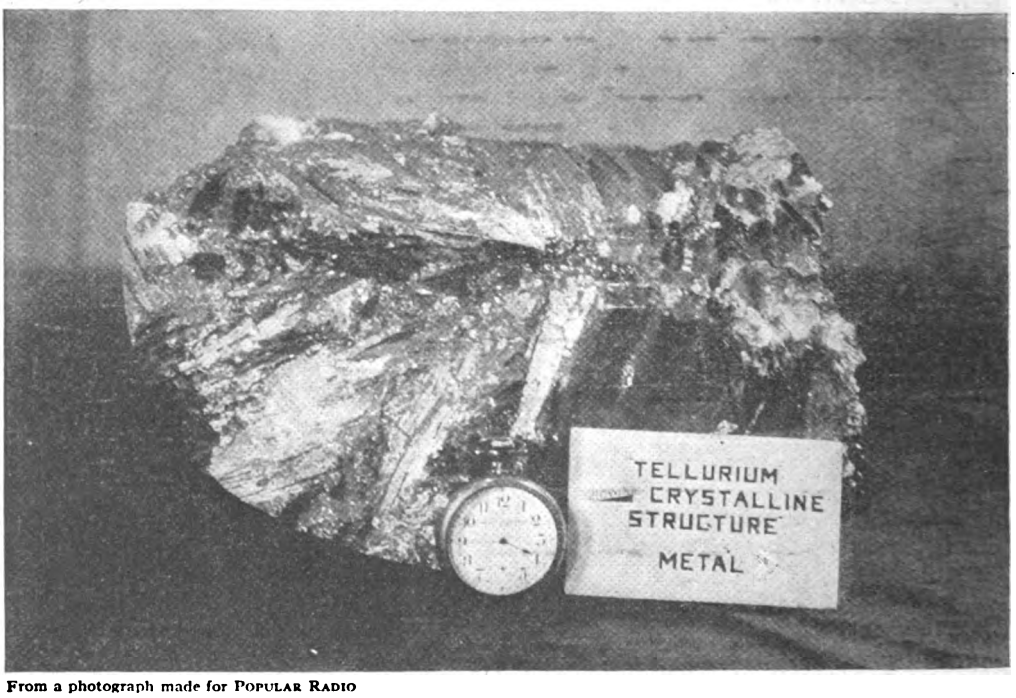
This idea has been confirmed by experiments by Dr. R. A. Millikan (the man who first isolated the electron) and Mr. C. F. Eyring, at the California Institute of Technology.* By exposing ordinary metal surfaces to electric fields as high as 200,000 volts they found it possible to pull a measurable number of electrons out of the cold metal.

It would be possible, no doubt, to construct a radio detector that would operate thus without a heated filament, using a plate-to-filament potential of 200,000 volts or more. The practical difficulties of such high voltages would far outweigh, of course, the advantage of dispensing with the hot filament, but the experiment is interesting because it confirms the idea that electrons *can* escape from filaments even in the cold. As the scientists come to understand more and more completely the way in which the electrons are held in metals and discharged from them there is promise, we believe, of securing cold filaments which will operate at voltages within the practicable range.

The Mysterious Effects of Light on Crystals

A NOTE in POPULAR RADIO several months ago mentioned the fact that strong light, especially sunlight, alters the behavior of crystal

*A paper before the American Physical Society, September 8, 1923; abstracted in the *Physical Review*, vol. 22, page 525 (November, 1923).



From a photograph made for POPULAR RADIO

THERE ARE MORE ELECTRONS IN THIS CRYSTAL THAN THERE ARE BRICKS IN NEW YORK CITY

When we know how all these electrons move about inside such crystals we may be able to solve the many mysteries in the behavior of tellurium as well as of the other substances used for radio crystals.

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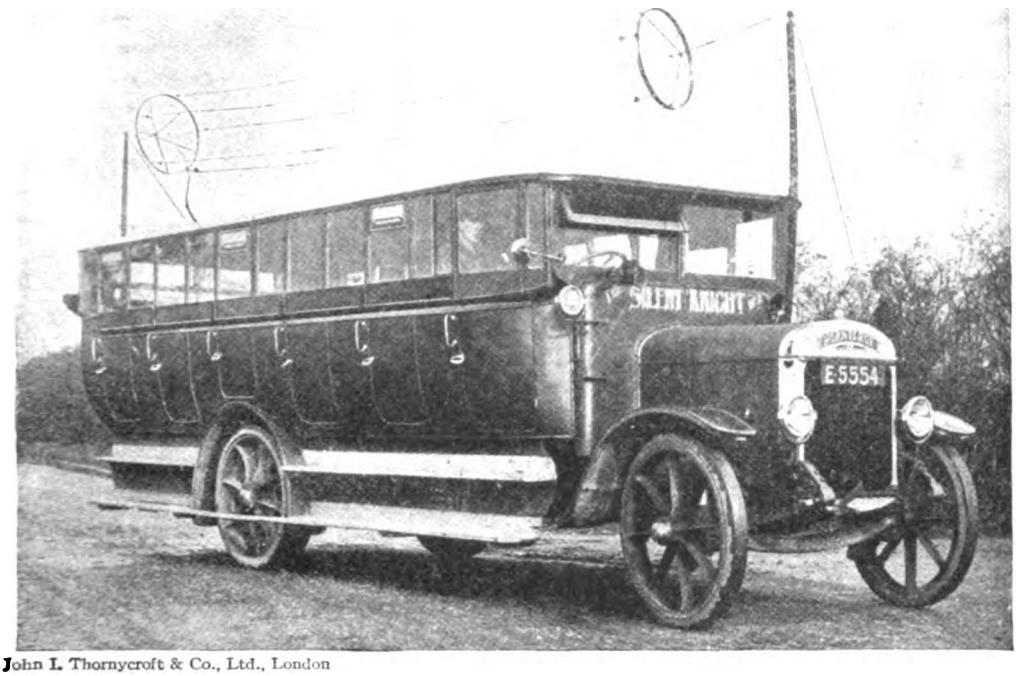

John I. Thornycroft & Co., Ltd., London

AN UNUSUAL ANTENNA FOR AUTOMOBILE RADIO

This motor omnibus, recently constructed in England, makes use of a cage antenna which is said to give more reliable reception than the single-wire or loop antennas that are commoner in the United States. Busses like this did good service in England during the recent railway strike.

detectors whenever the light is focussed on the surface of the crystal during the reception of signals.* The cause of this curious fact is entirely unknown, as are so many other causes that underlie the operation of our familiar combination of a galena fragment and cat-whisker.

Now comes Mr. Paul H. Geiger, of the Physics Department of the University of Michigan, with still another effect of light on the electric properties of crystals; another mystery for the crystal theorist to puzzle over.†

It has been known for some time that the electrical conductivity of a crystal was altered (under some conditions) whenever a strong light is allowed to fall on the crystal. Mr. Geiger set out to investigate this effect with crystals of the mineral argentite, which is a sulphide of silver analogous to galena, the latter being the corresponding sulphide of lead.

Mr. Geiger found, as he expected, that the conductivity of the argentite crystals was affected by light. But he found something else: something entirely new and unexpected. This was the production, inside the illuminated crystal, of an actual electromotive force. In some manner the crystal, or something in it, acts to convert a part of the energy of the light into electricity, just as a dynamo converts mechanical power into electricity. With a light of 600 candle power at a distance of 1 meter from the crystal the electromotive force produced was as much as .013 volt.

It is improbable, of course, that an effect so small as this (in volts) can ever be employed for the useful conversion of light energy into electric energy. That is not its promise of importance. The real promise lies in the chance of better insight into what really goes on electrically inside a crystal.

All of these electric and photo-electric properties of crystals—the light-detecting property of selenium, the emission of electrons when light falls on a metallic surface, the pressure effects which are responsible for the "talking crystals," even the familiar but mysterious behavior of the crystal as a radio detector—all these are related, we cannot doubt, to the properties of the electrons in the crystal.

It is these electrons which are sensitive, in some way, to the ether waves, both to the ether waves of radio and to the much shorter waves of light.

No field in all physics offers a greater promise of important discoveries, both in theory and in commercial practice, than does this one.

* POPULAR RADIO for January, 1924, page 83.

† "Spectro-photoelectrical Effects in Argentite," by Paul H. Geiger, *Physical Review*, vol. 22, pages 461-469 (November, 1923).

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CONDUCTED BY KENDALL BANNING

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

A Tip for Saving Your Vacuum Tubes

HERE is a practical hint from a fan in Sumner, Illinois, who reports that it is being observed to advantage by the listeners of his town:

Many radio users wire their sets so that a single battery switch cuts off both the loudspeaker field current and the tube filament current. When this switch is opened the filaments are left connected across the field terminals of the loudspeaker, and the discharge from this field throws a strong surge of current through the tubes—which is harmful. This is particularly harmful with the new low-filament-current tubes.

Look at your tubes when properly lighted, snap off your switch, and you will see that they flash up brightly for an instant. This is dangerous. You can avoid it by using separate switches to the loudspeaker field and to the filaments. The filament switch should be opened first.

—C. C. SCHUDER

Are Clouds a Source of Static?

THE recent discussion in POPULAR RADIO about the especial prevalence of static in the neighborhood of the mountains of Mexico brings this letter from a sea-going operator who thinks that the cloud banks over these hills may have something to do with it. He writes:

I am aboard a ship about 850 miles south of San Diego and am, therefore, in a position to give some dope about this problem. The static is a good deal stronger on the higher frequencies (600 meters) than it is around 15,000 meters. I do not know how to explain this. Of course, it is heaviest at night but it is fairly strong in the daytime also.

At this time of the year (winter) it is not so objectionable as during the summer months. I was here in April and in October, and it was so strong during the latter period that the tubes on the receiver actually choked. At times small sparks could be seen jumping around on the antenna switch. The mountains on the Mexican coast are not exceptionally high, but neither are they exactly mole-hills. In some places they are visible sixty and seventy miles at sea.

As to the point that the locality is not especially afflicted with thunderstorms I beg to differ. Of course, these disturbances are not so prevalent during the winter months, and they are not encountered so much fifty miles off the coast. But on a summer's night the lightning can be seen playing continuously over the mountains, and you may be sure this works considerable havoc with the radio.

It seems to me that this static has some relation to the clouds that are common in the vicinity of the Mexican mountains. On a clear day a thick bank of cloud will be visible above their tops and in no other place. According to the theory of electrical discharges between clouds and from clouds to the earth, it seems that we are approaching the solution of the mystery.

If this is really the solution of the mystery the next thing to do is to invent something to disperse those clouds. How would it do to warm up the sides of those mountains with artificial heat? Has anyone a suggestion of how this might be accomplished?

—FRED ROSEBURY

How Mountains Affect Radio Reception

HERE is a radio operator who is an officer in the U. S. Navy: he has some ideas along the same lines as those of Mr. Rosebury, but he has observed the same relation between static and clouds in other parts of the world as well:

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From personal observation I believe that I have a possible solution of the Mexican static problem. The static that becomes bothersome along in the middle of the afternoon, especially during the summer months in the temperate zones, is nearly always directional and comes from the direction of the coastal ranges. For ships off the east coast the direction is westward; off the west coast the direction is the eastward. This comes up in the middle of the afternoon and dies down about midnight or shortly before.

I have also observed, while off the coast of the Philippine Islands, that the same kind of static invariably became noticeable at approximately the same time when the sea breeze springs up in the middle of the afternoon. At the same time banner clouds appeared on the higher peaks of the coastal ranges.

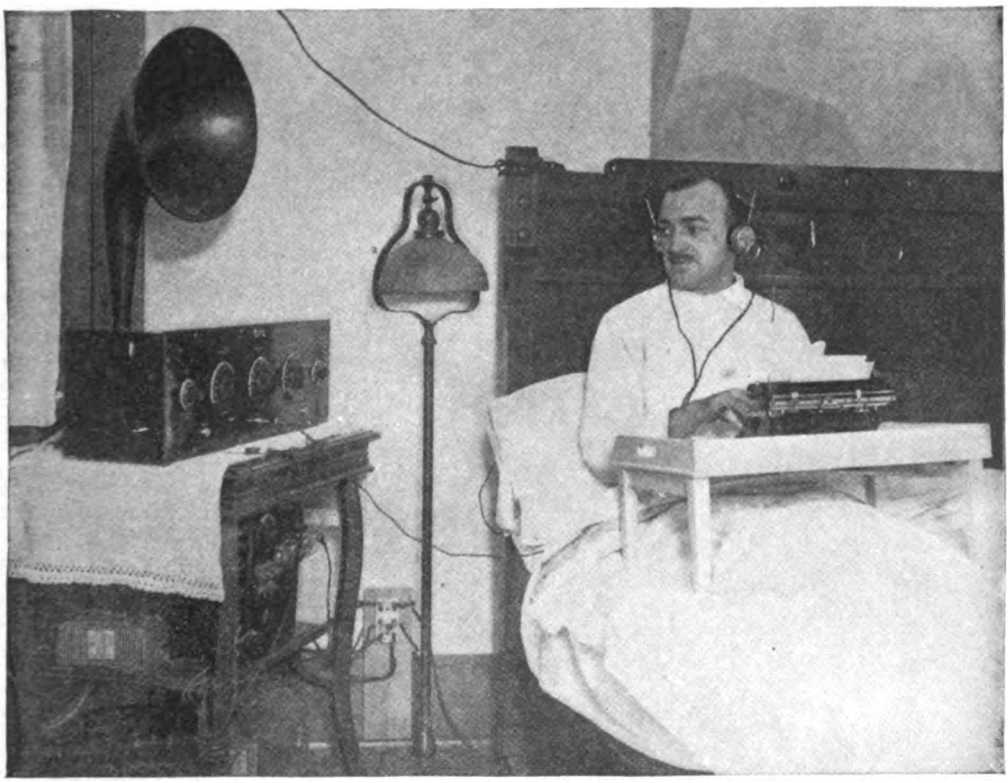
For a number of months during 1917-18 I was an operator on a United States warship doing patrol duty just outside of Manila Bay and I took particular notice of these facts:

1. There usually was no static when there was no sea breeze.
2. The regular afternoon static did not occur until shortly after the sea breeze started to blow.
3. The direction of this static was always from the high peaks of the coastal range.

These facts will easily account for the afternoon and evening static that occurs regularly during the summer months. It is caused by the condensation of the moisture in the warm breeze when this breeze strikes the colder peaks. This forms a mist and a steady static discharge from the particles of moisture in the mist to the peaks and to the banner clouds in contact with them.

Another instance of the relation of winds to static is the Kona, a well-known wind in the Hawaiian Islands. This wind blows for several days at a time and causes static so strong that stations near the Islands can receive only with great difficulty while these Kona storms prevail.

—R. J. OSTRANDER



Kadel & Herbert

"THE CHEERFUL LUNGER" RECEIVES 42 STATIONS IN A DAY

Mr. H. R. Thompson, during the past six months of a serious illness, at Lake Placid, N. Y., has developed into an ardent radio fan, who has become known to the announcers of the principal broadcasting stations through his letters in which he signs himself "The Cheerful Lunger"; many of the replies that he receives, indeed, are addressed with that title! He spends his time collecting DX records, and claims that the mental encouragement resulting from his interest in radio has been largely responsible for his rapid improvement in health.

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How to Cure the "Radio Ear"

A NEW affection of the ear is being reported by some radio fans, who sit for long periods at their receiving sets. It is called the "radio ear"; it is accompanied by noticeable pains in the auditory appendages even when not listening in. What it is and how to cure it is told as follows:

Sometimes the "radio ear" takes the form of sharp, shooting pains in the head near the ears; this causes fears of possible abscesses or other serious afflictions. Upon consultation, ear specialists usually say that the remedy is easy and fairly sure.

"You are a radio fan?" they ask. "You spend a good portion of your time with your headphones on?"

Upon receiving replies in the affirmative, the doctors say: "When you go home loosen up on your headphones; the spring is too tight and presses on some of the nerves of your ear." "Just like some forms of spectacles," they will tell you. "Your head set is undoubtedly causing the pains; relieve the excessive pressure and it will disappear."

International

A HANDFUL OF BROADCASTINGS

A crystal set in a tack barrel is one of the novelties that were exhibited at a recent radio show. The set was made by the young students of a public school.

One assurance is given of a benefit from radio head sets, however; youths of this generation are not so likely to have as protruding ears as some of their older brothers. All youngsters who sit for as much as three hours a day with their headphones clamped over their ears will grow up with close-fitting ears—at least so some experts believe. Mothers who formerly tied back their offspring's ears to prevent protruding will be saved that worry if they provide their children with radio receiving sets and headphones.

A Receiver That Eavesdrops on a Party Line

A FAN in Bondhead, Ontario, has discovered that his radio receiver gives him everything that passes over the telephone wires near his house. Doubtless the low capacity and high inductance that characterize a circuit when tuned to short waves give him an inductive coupling with some nearby telephone wire. He writes:

While testing a single-circuit regenerative set with two stages of audio-frequency amplification, I happened to try the lowest wavelength of which the set was capable, when I heard voices engaged in neighborly gossip and discovered that I had tuned in conversation from the local telephone party line. Further tests brought in conversations from still other party lines, and what sounded like the operation of a large telephone exchange, with the ringing-in and plugging-in of calls. I find that I can consistently get anything on our own line, and sometimes on other lines. When my telephone bell rings I can hear it in the phones.

I am about seven miles away from the small party-line telephone exchanges and forty miles from the large Toronto exchanges, such as I believe I can hear at work. My radio set is about twenty feet away from the telephone and in another room. The telephone ground is some fifty feet from the radio ground. One party line from which I picked up conversation has no connection with ours, belonging to another company. It runs past the house across the street. My antenna is fifty or sixty feet from the nearest telephone line.

I have an umbrella type antenna on the roof, also an inside antenna strung just under the roof upon the rafters in the attic. The inside antenna gives the telephone conversation much better than the outside antenna. My explanation for that is that the inside antenna is strung parallel with the telephone wires which run past the house outside.

I had a local telephone man in listening to the radio demonstration of party-line telephone conversation, and he gave it as his opinion that the telephone system was grounded somewhere, and that I was getting it through the ground. This will not hold, however, as I detached the ground wire and still the telephone

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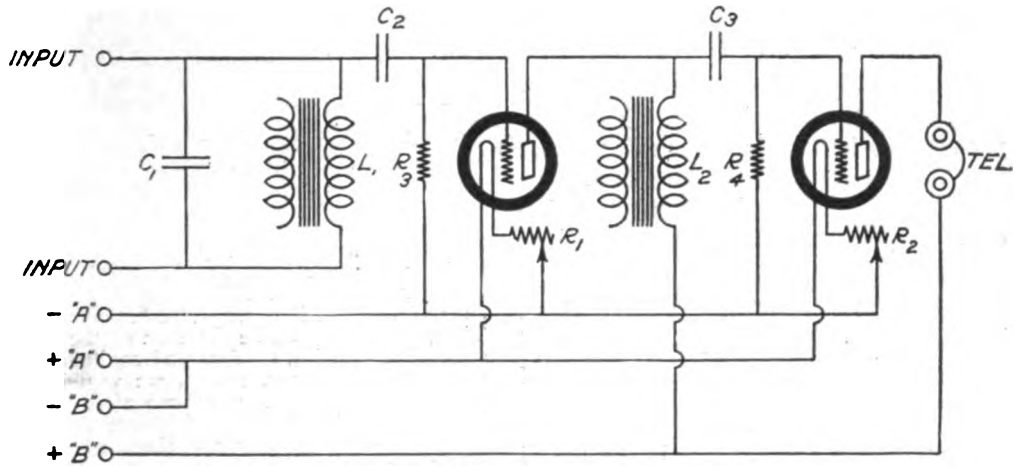

FIGURE 1: *The wiring diagram for an impedance-coupled, audio-frequency amplifier. The coupling impedances L1 and L2 are Ford ignition coils.*

conversations could be faintly heard. When the antenna was detached, and the ground left on, the results ceased completely.

The other evening, using two stages of audio-frequency amplification and a standard variometer set, I got loud results without either antenna or ground. Upon another occasion, I placed a single-circuit regenerative outfit on top of a standard variometer one with only the batteries connected to the upper set and with the regular connections to the lower set. I could tune in anything on the upper one.

Believe me, if radio means that one can listen-in on the telephone party line without running the risk of getting caught listening at the telephone, there is bound to be a tremendous radio boom in the rural districts. As an attraction, the best broadcasting cannot compete with this.

—REV. A. W. HONE

A Home-made Choke-coil Audio Amplifier for $10.00

FEW radio enthusiasts are aware of the possibilities of choke-coil amplifiers, yet this type of amplifier costs less to construct than one that is transformer-coupled. It is also easier to wire up, and if it is well constructed, it will give very fine results, both in volume and clarity of tone. At least that is what amateur 1-ACA has found during about nine years of experimenting with amplifiers of all kinds. He writes:

Ford ignition coils make excellent choke coils for this purpose and discarded Ford coils generally may be purchased at any garage for a few cents. The main point to remember when buying one of these used coils is, that the secondary winding must be unbroken and, of course, the iron-wire core must be intact. The primary winding is not used and may be left as it is. If a used coil it not to be had a new one may be bought for $1.75, which is somewhat lower than the price of a good amplifying transformer.

Below is a list of the material required to construct a two-stage choke-coil amplifier:

2—Tube sockets at 35 cents each...	$ .70
R1 and R2—Rheostats at 75 cents each	1.50
L1 and L2—Ford coils (new) at $1.75 each	3.50
1—Panel, size 8 inches by 6 inches..	.75
C2—Grid condenser (.002).....	.25
C3—Grid condenser (.003).....	.25
C1—Shunt condenser (.001).....	.25
6—Binding posts at 5 cents each....	.30
R3 and R4—Grid-leaks, 2 megohms at $1.00 each.....	2.00
Wire for connections and sundries..	.50
Total cost.....	$10.00

By using but one rheostat to control the filament current for both tubes the cost can be slightly decreased without detriment to the set.

In the diagram (Figure 1) it will be noted that a small fixed condenser of .001 mfd. is shunted across the secondary winding of the first choke coil. On succeeding stages this condenser is not required.

I find that on the second stage two chokes in series will provide a slight increase in signal strength. The addition of this extra coil on the first stage makes no noticeable difference in the reception. Note also that grid condensers are used on all the tubes. These are necessary to keep the high voltage D C. from the "B" battery off the grids of the tubes.

—LESLIE A. DIDSBURY

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Will We Have An "American Radio Time" Standard?

SO many fans have trouble in interpreting the times of radio schedules for stations located in distant time zones that this suggestion of a La Plata, New Mexico, enthusiast is interesting because it points out a possible solution:

At present three different "times" need to be taken into account by the majority of radio receivers in the United States—the times of three of the "standard time zones" into which the country is divided. The times of different stations differ and any error in the identity of a station causes misunderstanding as to the time of future announcements.

After railway consolidation had extended the operations of the single railway units there was a similar difficulty which was relieved by the system of standard time zones now in use. *One* standard time would be still better for radio use. The following seem to be reasonable suggestions:

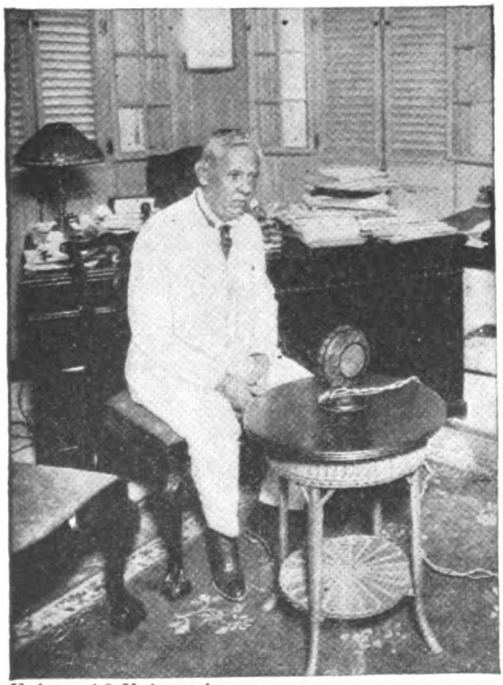
1. Let Central Standard Time (the time of Chicago and the middle west) be known hereafter as "American Radio Time." If all radio stations use this time it would soon extend to both American continents and to adjacent waters.

2. All radio announcements should be made in this time, thus: "President Coolidge will speak on April sixteenth at 8:30 P.M., American Radio Time, wavelength 360 meters."

If this plan were adopted, a wide use of radio time would probably follow in general business for telephone appointments and the like between distant cities. Another natural extension of the idea would be "Pacific Radio Time," which would be the time of the International Date Line, 180 degrees Longitude from Greenwich. Perhaps, finally, we would have "India Radio Time" for the time of 90 degrees East Longitude. This would have the same clock reading as American time, but would be A.M. when the American time was P.M., and *vice versa*.

Throughout the world there would be, then, only two clock readings for a given instant in radio time. The hour hands would be six hours apart. The minutes and seconds would be the same everywhere.

—HARRISON H. BROWN



Underwood & Underwood

THE CUBAN PRESIDENT ADDRESSES HIS PEOPLE

When Alfredo Zayas, the head of the Republic of Cuba, talks into the microphone installed in his office by the Cuban Telephone Company of Havana, his voice is broadcast over his entire country—and laps over onto several other countries as well.

Wiring a House for Radio

SO many fans are arranging to provide radio concerts all over the house that the suggestions of this Long Beach, California, amateur will strike a popular chord:

As I wanted to have radio in the different rooms of my house, I ran insulated wires under the floor of the house, attaching them to insulators wherever necessary, and providing outlets in my den, in one bedroom, and in our living room.

For each outlet I ran the wires to a regular two-prong jack, fastening the jack to a piece of bakelite about two inches square. I inserted this jack in the floor, the receiving end upward. Thus, the wires could be attached conveniently to the points of the jack underneath the floor. From each jack, a pair of wires run to my radio table to which they are attached by a plug with a surplus of about 3 feet of wire.

When I want to receive in any particular room, I tune the set properly and then plug in, at the set, the wires for the room that I want to connect. Then I take my loudspeaker into that particular room and plug it in. The line loss is so slight that you cannot notice it, even in one of the rooms the distance to which is over forty feet.

This gives you radio where wanted with no long wires to trip over when walking about. During sickness in our home last winter we had programs right in the sickroom and it was great.

—HORACE G. HAMILTON

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IF *you are getting good results with your receiving set, tell your fellow-readers of* POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

HAYNES CIRCUIT IS PRAISED

"I HAVE been using a single-circuit tuner, but I tried the Haynes circuit which you published in September and find that it is everything you claimed that it was," writes A. J. Thompson of Memphis, Tenn. "I find the set more sensitive than the single-circuit tuner and absolutely free from body capacity.

"One night last week I listened to sixteen stations. I get WGY of Schenectady, N. Y., on the loudspeaker so that it can be heard all over three rooms."

Other stations he hears, using dry-cell tubes and two stages of audio-frequency amplification, are PWX of Havana, Cuba; WEAF, New York City; KDKA, Pittsburgh, Pa.; WWJ, Detroit, Mich.; WDAP, Fort Worth, Tex., and KYW, Chicago. He listened to KHJ, Los Angeles, Calif., on three consecutive nights.

* * *

FIFTY STATIONS ON A CRYSTAL

ARTHUR HALL of Oakland, Calif., reports hearing a total of 50 stations on a home-made crystal receiving set, 21 of them more than 300 miles away. He uses a two-slide tuning coil and an antenna 135 feet long. His best results were obtained in summer.

"When I first made the set, I could hear only the local stations," he says, "but in a month, after learning more about the instruments, I finally heard a station 70 miles away. From then on I heard farther and farther, and still hope to hear over greater distances. My records were made in the direction of north and south, because my antenna points that way. I am going to change it and add some eastern stations to my list."

Stations up to 700 miles distant he can pick up almost any night, he maintains. The crystal he uses is galena, and he believes he has tried them all.

VISITS ALL PARTS OF THE COUNTRY

"THE minute I turned on my new Cockaday four-circuit tuner I got WGY, Schenectady, 1,200 miles away," writes John C. Holland of Little Rock, Ark. "Then I got more, just as fast as I could tune them in."

He says he hears everything from San Francisco to Newark, N. J., and from Calgary, Canada, to Havana. His set is located in the heart of the business district, with tall buildings, power lines, telephone cables and tin roofs surrounding it.

* * *

A SPEAKER ON ONE TUBE

LOCAL stations operate a loudspeaker for A. W. Thomson of Orange, N. J., with a dry-cell tube and the DX circuit published in POPULAR RADIO for January, 1923. It consists of two fixed coils, a variometer and two variable condensers.

He hears two stations in Chicago with his little 1½-volt tube, as well as WSB of Atlanta, Ga., WOC of Davenport, Ia., and WGY of Schenectady. The clarity and sharpness with which these and other stations come in lead him to think he will hear from Denver and Ft. Worth on clear winter nights. His antenna is 80 feet long and 38 feet high.

* * *

WITH A POWER-LINE ANTENNA

"I BUILT the Haynes set described in POPULAR RADIO," writes J. W. T. Patton of Truro, Nova Scotia, "and with WD-12 tubes, dry batteries and a plug in my light socket for an antenna, I hear:

"WGY, Schenectady, N. Y.; WMAF, South Dartmouth, Mass.; WHAZ, Troy, N. Y.; WJAR, Providence, R. I.; WOR, Newark, N. J.; WWJ, Detroit, Mich.; KSD, St. Louis, Mo., and WOAW, Omaha, Nebr. WWJ was as clear as if the speaker were in the room with me."

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HIS SET NEEDED A BATH

A good bath refreshed the set of H. C. Torreyson of Genesco, Ill., and changed it from an ordinary receiver into what he now calls a marvel.

"I built the Cockaday four-circuit tuner described in the May issue of Popular Radio," he states, "but at first was unable to hear for more than 200 or 300 miles, due, I think, to the fact that I used acid flux in soldering.

"One day I washed the set in alcohol and dried it thoroughly in an oven. That night I tuned in Regina, Sask, and Los Angeles, Calif. Since then I have been able to reach the Pacific Coast almost any night after eleven o'clock."

Following is a sample of one night's "travel":

5:56	KYW, Chicago, Ill.
6:11	WOC, Davenport, Ia.
6:20	WDAP, Chicago, Ill.
6:25	WGR, Buffalo, N. Y.
6:47	WSAI, Cincinnati, O.
6:50	WGY, Schenectady, N. Y.
6:54	WMAG, Chicago, Ill.
7:05	WJAX, Cleveland, O.
7:17	WPAD, Chicago, Ill.
7:21	KDKA, Pittsburgh, Pa.
7:46	WHAS, Louisville, Ky.
7:57	WCAE, Pittsburgh, Pa.
8:00	WCAP, Washington, D. C.
8:11	WSB, Atlanta, Ga.
8:13	KSD, St. Louis, Mo.
8:16	WHB, Kansas City, Mo.
8:23	WLAG, Minneapolis, Minn.
8:39	WTAS, Elgin, Ill.
8:42	WFAA, Dallas, Tex.
9:01	WMC, Memphis, Tenn.
9:05	WPAW, Omaha, Nebr.
9:30	WJAZ, Chicago, Ill.
9:43	WLW, Cincinnati, O.
9:49	WOAI, San Antonio, Tex.
9:55	WFI, Philadelphia, Pa.
10:00	CKCK, Regina, Sask.
10:08	WBAP, Ft. Worth, Tex.
10:25	WRAL, St. Croix Falls, Wis.
11:13	WBAK, Harrisburg, Pa.
11:15	KHJ, Los Angeles, Calif.
11:46	WDAF, Kansas City, Mo.
12:06	KFZ, Los Angeles, Calif.
12:15	9XN, Chicago, Ill.

This total of 33 stations represents a journey of 17,275 miles in one evening. The antenna used was a single wire, 125 feet long, one end 40 feet high and the other end temporarily fastened to a bush two and a half feet above the ground.

* * *

THE OLD HONEYCOMB AGAIN

One tube and three honeycomb coils will make one famous in England, according to W. Poynter of London, if they are used properly. He has heard both WEAF and WGY on his detector tube alone.

The coils are connected in the usual double-circuit, regenerative hook-up, with vernier condensers.

"To my mind," he explains, "reception was possible partly by use of a double circuit and vernier condensers, plus a little patience."

* * *

IT'S ALWAYS FAIR WEATHER

In spite of heavy rain, thunder, lightning, static, code interference and heavy wind, stations WEAF of New York and WGY of Schenectady, N. Y., were heard in Loughborough, England, on three tubes by R. G. Burder.

"The reception was very good," he writes, "and the announcer at WGY particularly distinct. I heard one other station, but was unable to ascertain its call letters."

His set contains one stage of radio-frequency amplification, detector and three stages of audio-frequency. For the test he used only one stage of audio frequency. His antenna is a single wire of the seven-strand variety, 100 feet long and 50 feet high, and his ground connection is made to a water pipe.

* * *

CRYSTAL SET ADDS TO CAMP EQUIPMENT

A radio set is going to be an essential part of all camp equipment hereafter when John A. Simmons takes to the woods in the summer, for his little crystal set, using a single-tapped coil, picked up Station WEAF of New York when he was more than 100 miles away in the New Jersey woods.

The queer part of it was, according to Simmons, that his antenna was hastily thrown into a tall tree. He tossed the antenna, a single wire, into the tree after he had pitched camp late in the evening, thinking that if it did not work he would change it in the morning.

"It worked so well that I was afraid to change it," he says, "and I left it there for five days."

The antenna was number 14 wire, insulated, about 75 feet long. A ground connection was made to a tin can dropped into a small stream.

* * *

IN SPITE OF THE LANDLORD

"I must use an indoor antenna in a room eleven by eleven feet," writes James Bolton of Richmond, Va., "but I have successfully picked up Chicago, Davenport, Cleveland, Schenectady, Havana and a number of intermediate stations.

"My present set, the best one I have made, is designed from the British tuned-anode, published in the October issue of Popular Radio. A forty-three plate condenser is used in series in the antenna circuit, and WD-11 tubes are employed throughout. I use 22½ volts on the detector and 45 on the amplifiers. Last night I heard KDKA, Pittsburgh, Pa., and WGY, Schenectady, N. Y., with my phones held at arm's length."

* * *

THE FEED-BACK CIRCUIT IS SIMPLE

"With only one dial to turn, I hear Chicago, Cincinnati, Pittsburgh and Springfield, Mass.," writes A. F. Hendren of Passaic, N. J. These stations he hears with but one dry-cell tube. With two more dry-cell tubes in an audio-frequency amplifier, he hears the stations fairly well on a loudspeaker. Local stations have unusual volume, he says.

His secret is a fixed condenser of .002 mfds. which feeds back the plate current into his antenna circuit. His primary and secondary coils are fixed and he tunes with a variable condenser. The antenna used is about 69 feet long.

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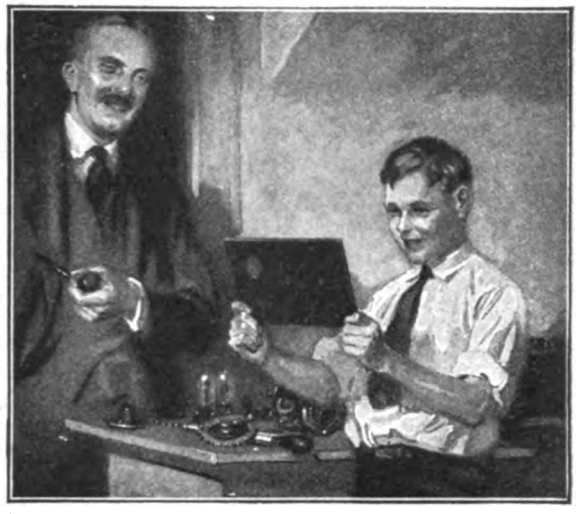
"Wait till Mac sees this panel"

THE finished radio panel is a beautiful job. It's a better-looking panel than the one in Mac's set next door. And Mac has the finest set in the neighborhood.

Hundreds of radio fans are giving their home-built sets the same snappy, professional appearance by mounting their instruments on Celoron Radio Panels. Some like the glossy black Celoron panels. Others get the mahogany or oak finish. They all find they can drill clean holes anywhere in Celoron panels without chipping the smooth, hard surface.



"Doesn't she look great, Dad? Every hole is as clean as a whistle."

Celoron as insulating material

Good looks aren't all a Celoron panel gives your set. This panel's high dielectric strength increases the volume of your set and helps you get results from your instruments that you wouldn't get with a cheap panel.

Celoron Radio Panels were the first to be cut in standard sizes and sold in separately wrapped packages. They come in the following standard sizes:

1—6 x 7 x 1/8	*5— 7 x 18 x 3/16*
2—7 x 9 x 1/8	*6— 7 x 21 x 3/16*
3—7 x 12 x 1/8	*7— 7 x 24 x 3/16*
4—7 x 14 x 3/16	*8—12 x 18 x 3/16*

9—7 x 26 x 3/16

Other sizes can be cut to your order from sheet stock. See your dealer.

Celoron, a bakelite product, is one of the best insulating materials known. It is approved by the U. S. Navy and U. S. Signal Corps. Leading radio manufacturers mount their parts on Celoron bases.

Ask your dealer for a Celoron panel. You can identify it by the Celoron label that is on every panel. These panels come already cut in nine standard sizes ready for working. A dust-proof glassine wrapper protects each panel surface. Full instructions for working are on every envelope.

Send for our free booklet, "Getting the Right Hook-Up with Celoron." It contains diagrams, list of broadcasting stations, and radio information every set-builder should have.

To radio dealers: Send for special dealer price list showing standard assortments.

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STANDARD RADIO PANEL

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"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"

Why big cells count in Radio "B" Batteries

THIS handsome metal case Eveready "B" Battery No. 766 costs only two-thirds more than the smallest Eveready "B" Battery, but it *contains seven times the electricity!* This makes the No. 766 over four times as economical as its baby brother. That is why most people buy it.

Its fifteen large cells give 22½ volts of strong, steady, energy day after day. Cells that pour out power the moment you turn on your tubes. Cells that rest well when idle, renewing their vigor for your next demands.

No cells have a bluer-blooded ancestry than these. They are the product of thirty years of dry battery research and development of the world's foremost electro-chemical laboratories.

Eveready 6-volt Storage Battery

No. 764 The Space Saver Vertical 22½-volt "B" Battery

Eveready Radio "A" Dry Cell Specially manufactured for use with dry cell tubes

No. 767 "B" Battery, 45 volts Variable taps, Fahnestock Clips

No. 771 "C" Battery Clarifies tone and increases "B" Battery life

Please refer to POPULAR RADIO *when answering advertisements.*

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"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"

Eveready "B" Battery No. 766. 22½ volts. Six Fahnestock Spring Clip Terminals, giving variable voltage from 16½ to 22½ volts, in 1½-volt steps. Length, 6¾ ins.; width, 4⅛ ins.; height, 3 3/16 ins. Weight, 5 lbs.

WE THINK that No. 766 is the handsomest battery ever made. But that is a matter of opinion. It is a matter of engineering record, however, that this great standard "B" Battery has proved itself as perfect in performance as we are convinced it is superfine in appearance.

The 45-volt Eveready No. 767 contains the same large powerful cells as the No. 766. For maximum "B" Battery economy, therefore, buy the 22-½ volt Eveready No. 766 or the 45-volt Eveready No. 767, as you prefer.

NATIONAL CARBON COMPANY, INC.
Headquarters for Radio Battery Information
New York San Francisco

Canadian National Carbon Co., Limited
Factory and Offices: Toronto, Ontario

If you have any radio battery problem, write to G. C. Furness, Manager, Radio Division, National Carbon Company, Inc., 128 Thompson Ave., Long Island City, N. Y. Informative and money-saving booklets on "A," "B" and "C" Batteries sent free on request.

EVEREADY
Radio Batteries
—they last longer

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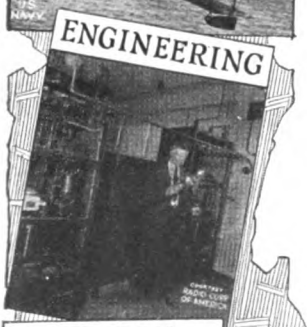
"Cash In" On These Amazing



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The pictures on this page give only the smallest indication of the scope of Radio today. Mail the coupon on the next page for my Free Book which gives full facts on Radio and what it can mean to you.

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You're interested in Radio—why not turn your interest into profit? Why not make big money in work you enjoy? No field today is growing so rapidly. No business offers such a rare variety of opportunities. Radio is a new, billion dollar industry in which thousands have already made far more money than they ever dreamed possible.

Radio can take **you** out of the rut of bare existence—into an enviable field of high salaried specialists. It can offer you unlimited opportunities for honor, wealth, power and satisfaction. It means a future filled with boundless promise!

Recognized Radio Experts In Urgent Demand

Readers of POPULAR RADIO know in part the story of how Radio has jumped forward with leaps and bounds. You know there are broadcasting stations all over the country—that radio is used on every ship—that it is used by newspapers, government departments, business houses, banks, railroads, factories and stores. Every day, some new use for Radio is announced. And this wonderful expansion of Radio has opened up hundreds of splendid positions on land and sea—positions which you can qualify for within a few months!

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New Opportunities in RADIO!

There's **big money** in this wonderful new field for you. No matter what you are doing—no matter what experience you've had, you can step in and get your share of the astonishing rewards of Radio. Big salaries, fascinating, easy work, short hours, and a wonderful future—no other field of endeavor can offer anything to compare with what Radio can mean to the men who get into this work now.

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E. R. Haas, Director, NATIONAL RADIO INSTITUTE (Founded 1914)

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Not a week goes by without our receiving urgent calls for our graduates. "We need the services of a competent Radio Engineer," writes a prominent radio firm. "Would appreciate your recommending any person who could fill position." "We want men with executive ability as well as radio knowledge to become our local managers," writes another firm. "We will require the services of several resident demonstrators," writes still another—and these are just a few small indications of the great variety of splendid opportunities open to our graduates!

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No previous training in electricity or radio is necessary. During your spare time at home, within an amazingly short time, you can get your National Radio Institute diploma, which is government recognized and accepted as part credit on your government license. To make the training more practical, circuits and parts for building latest receiving sets are now included FREE with the course.

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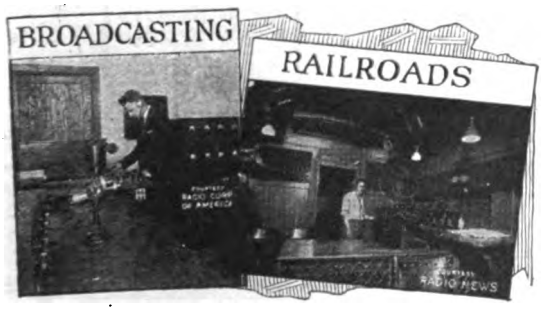
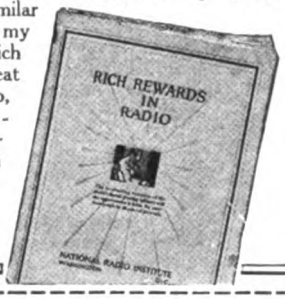


I Can Qualify You as a Radio Expert in a Few Months

If you want to earn far more money than you are earning now—if you want to be your own boss—if you want a profitable business of your own—if you want to travel the world over—if you want a field of endeavor where the opportunities are unlimited—Make RADIO your profession.

Hundreds of my students write enthusiastically of my training—and tell how it has helped them. Merle Wetzel now is making three times what he did before taking my training. Emmett Welch started at $300 a month after graduating. Scores of others tell similar stories. Send for my Free Book which tells of the great opening in Radio, what my students are doing—what you can do. No obligation. Mail the coupon **nw.**



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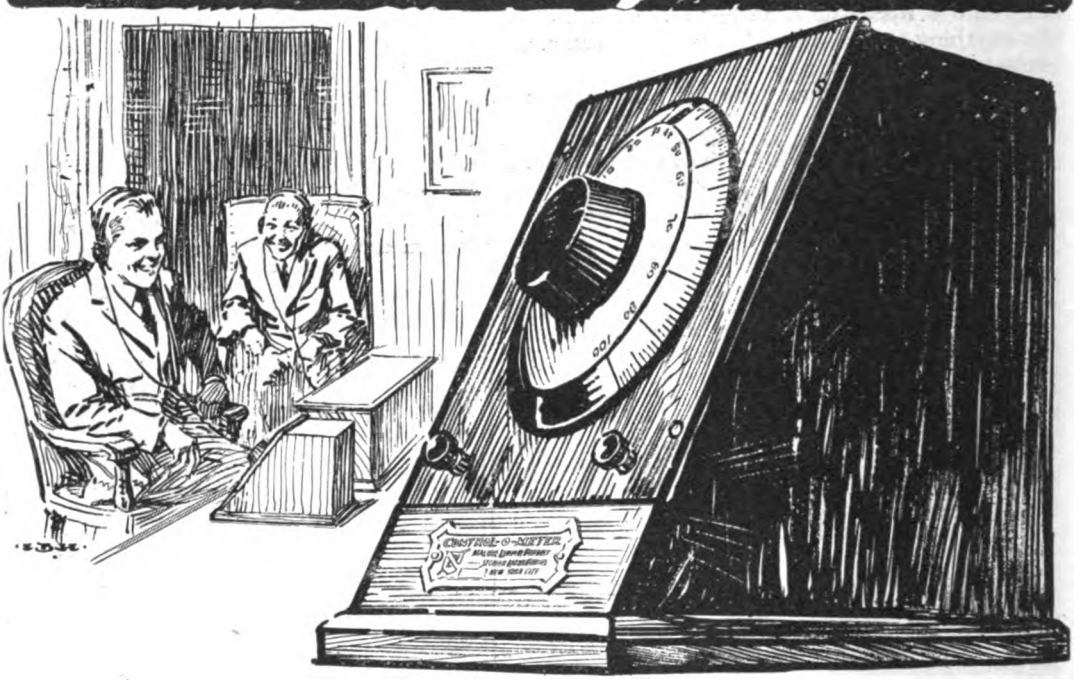
MALONE-LEMMON CONTROL-O-METER



Adding a Malone-Lemmon Control-o-meter to your set means adding the power of selectivity — selectivity which will

1. Allow you to separate two local stations and hear either without interference from the other.
2. Allow you to hear distant programs while local stations are "on the air."
3. Allow you to separate two overlapping distant stations. This feature is of particular value to Neutrodyne owners.

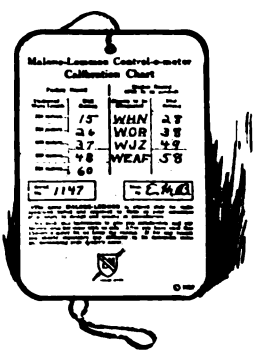
The Malone-Lemmon Control-o-meter will do these things at a turn of the dial — do them consistently, regardless of your location, type of set or antenna. Price complete $12.50.

Send for Literature

We have prepared a series of folders describing in detail the Control-o-meter and other Malone-Lemmon Products. We will be glad to send you the complete series.

The Chart Makes It Easy

Each Control-o-meter is individually calibrated in our laboratory and a chart is supplied with each instrument showing the "vanishing points" for various wavelengths.



MALONE-LEMMON PRODUCTS

Made by STEPHENSON LABORATORIES

342 MADISON AVENUE

NEW YORK CITY

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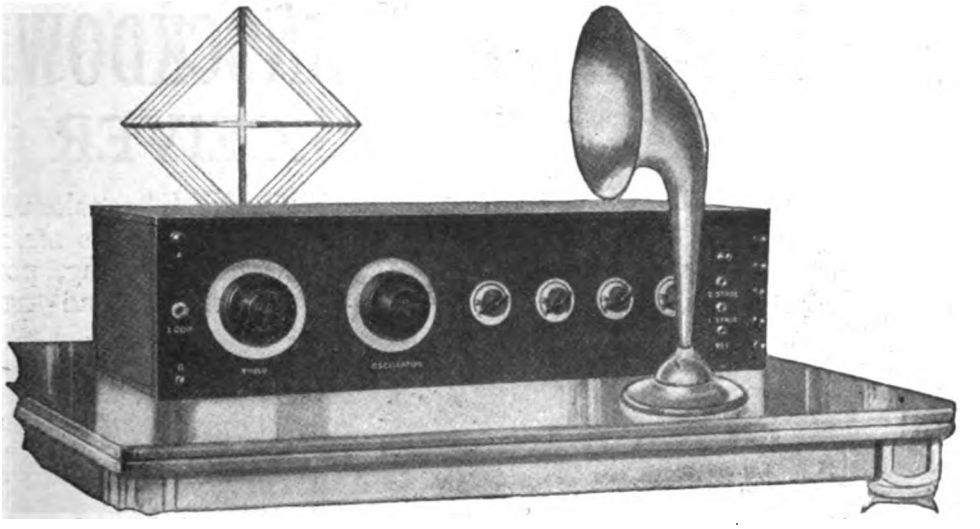
"THE STANDARD OF COMPARISON"



Most Selective Receiver Known

Ultradyne Kit includes tuning coil, oscillator coil, one Ultraformer type "A," three Ultraformers type "B"

$24.50

Send for the 32 page illustrated book giving latest authentic information on drilling, wiring, assembling and tuning 6 and 8 tube Ultradyne receivers.

50c

ULTRADYNE
The Improved
SUPER-HETERODYNE

Employs "Modulation System," an entirely new principle of radio reception just developed and perfected by R. E. Lacault, A. M. I. R. E., technical editor of *Radio News* and formerly Radio Research Engineer with the French Signal Corps Research Laboratories.

This principle is of such a basic character that the sensitiveness is increased over that of any known receiver. Weakest signals are made to operate the loud speaker. Results secured by the Ultradyne exceed by far those obtained with reflex, super-regenerative, Neutrodyne and even the well-known Super-Heterodyne. This is true in regard to selectivity, range, signal audibility, simplicity and general efficiency.

The "Modulation System" is employed exclusively in the Ultradyne, the improved and simplified Super-Heterodyne.

Write for descriptive circular

PHENIX RADIO CORP.
3-9 Beekman Street New York City

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A Freed-Eisemann KNOCKDOWN NEUTRODYNE RECEIVER

Unassembled Model KD-50
Freed-Eisemann Neutrodyne Receiver

NOW the opportunity is presented to obtain a complete set of parts, recommended by the manufacturer, to work with each other in building your Neutrodyne set. An illustrated 32-page book on how to build the Neutrodyne with full-sized diagrams and templates included.

Complete
With full Instructions

$80

Dealers Write for Name of Nearest Distributor

NEUTRODYNE has taken the country by storm. It is *the* remarkable distance getting, powerful, non-oscillating and non-whistling receiver.

A 32-page book answers every question. The panel is accurately drilled. A baseboard is furnished; in fact, everything down to the very last screw and nut, including all necessary parts excepting the cabinet.

Besides the book there is furnished schematic blueprints and template for drilling the baseboard, also full-size pictorial perspective wiring diagram, so that it will hardly be possible for the amateur with ordinary care and skill to make an error.

Remember that here are licensed parts—not a collection of apparatus trusting to luck that they will assemble properly. Each part is *designed* and fitted to work with each other part in this particular set. The instructions are so complete and the parts so accurately matched that you will be grateful for the manner in which we have eliminated guess work in the amateur construction of this receiver.

For sale by dealers of the better class throughout the country, for amateur and experimental building. Builders are cautioned against attempting to build a Neutrodyne Set with parts which are not recommended and designed by the manufacturer to work with each other.

Front View KD-50
Neutrodyne Being Assembled

32-page illustrated book of instructions on "How to Build the Neutrodyne" with full size pictorial wiring diagram and full size panel and baseboard templates. $1. At your Radio Dealers.

Freed-Eisemann Radio Corporation

SPERRY BUILDING MANHATTAN BRIDGE PLAZA BROOKLYN, N. Y.

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"My friends all tell me that my Manhattan is the best Loud Speaker they have ever heard"

Mitzi

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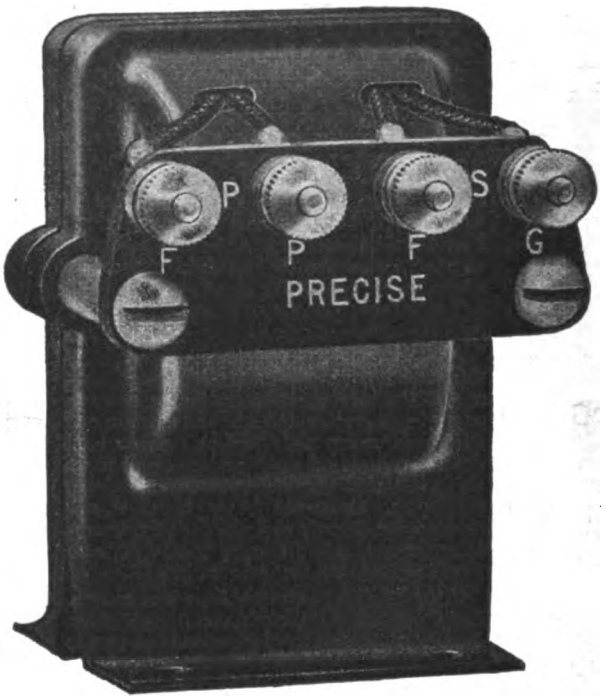
The Transformer Sensation of Modern Radio

Model 285A
$5.75



Ratio
- 4½ to 1

An Audio Frequency Transformer

Built to the exacting needs of present day broadcasting reception, producing volume with pure realistic tone qualities.

Highly recommended by radio engineers for use in **American Super Sets** and **Neutrodyne Circuits.**

Ask your dealer or write direct for test chart #1094 and electrical characteristics.

Every instrument is sold with the **guarantee of satisfactory performance.** Our attractive sales proposition is of interest to DEALERS and JOBBERS.

PRECISE MANUFACTURING CORPORATION

53 W. Jackson Blvd.
Chicago, Illinois

Rochester, New York

821 Market Street
San Francisco, Cal.

Canadian Distributors:
PERKINS ELECTRIC, LTD.
Toronto **Montreal** **Winnipeg**

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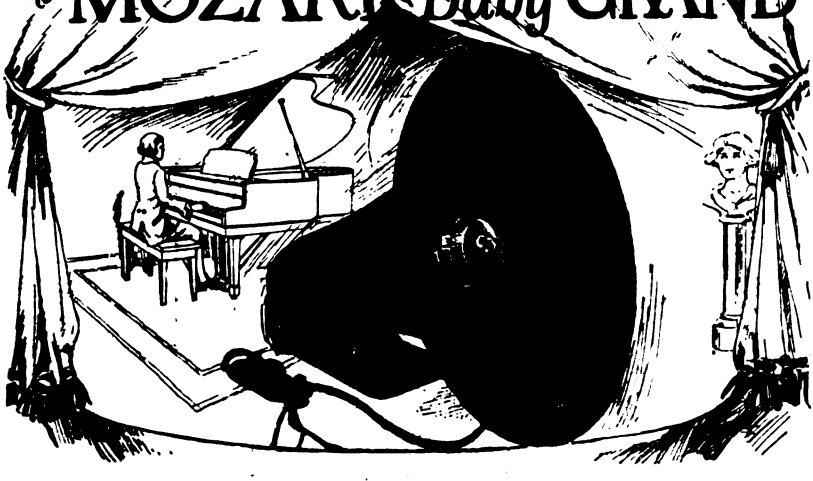
Introducing The MOZART *Baby* GRAND



WE announce with pleasure entering the radio equipment field with our complete line of Mozart *Baby* Grand, Mozart-Grand and Mozart *Concert* Grand "reproducers." Shipments have commenced on the Baby Grand with a special request to every individual purchaser that they make a minute comparison of their purchase from every aspect, not with other instruments of a similar price, but with the largest and most expensive on the market today. We are, with the utmost confidence, staking the whole of our resources on the result.

While instruments of the reflex type, broadly speaking, are not new, our design is entirely original and has been developed with a technical and practical care, probably never previously bestowed on this class of merchandise. Its extraordinary reproducing qualities, its extremely low center of gravity, with resultant steadiness and its general beauty of outline guarantee it a worthy place among all that is superlative in radio necessities today.

The color scheme is black and gold. The unit and other fittings are heavily gold plated, the combination resulting in a charming effect which will harmonize perfectly with any furnishings from the simplest to the most pretentious.

The dimensions, etc., of the Mozart Baby Grand are: diameter of bell, 12″; height overall, 12½″; length overall, 12½″.

Price complete with unit and cord, ready for attaching... $10.00
West of the Rockies..... 10.60
Price of unit only, with cord, ready for attaching..... 4.00

Applications to market our products invited from radio houses of repute.

Communications by mail only. Address Radio Department.

MOZART-GRAND CO.

Manufacturers of fine Instruments.

NEWARK, N. J. **U. S. A.**

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You Can Build With Confidence When You Demand This Trade Mark

Radio men of experience agree that more sets are ruined by careless buying than by careless construction. Most people take pains to see that diagrams are followed faithfully—that connections are tight—and instruments are properly placed. But this alone cannot assure results—the poor design of one single part can destroy the efficiency of the most elaborate set. Radio parts must be purchased with a knowledge of their maker—it is the only measure of their quality of which the average buyer can be certain.

A Complete Line of Radio Current Control Apparatus by the Most Famous Electrical Control Engineers

For more than a quarter of a century the name Cutler-Hammer has been demanded by engineers throughout the world in their specifications on current control. Gliding under the sea on the delicate apparatus of submarines; shooting skyward on the operator's handle of the modern office building elevator; keeping day and night watch over thousands of automatic industrial machines—in every branch of industry and in every country in the world you will find this famous trade mark justifying the confidence with which it was demanded In radio it affords an easy way to be sure of quality in the parts you buy, demand it and build with satisfaction.

THE CUTLER-HAMMER MFG. CO

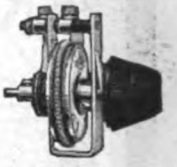
Member Radio Section, Associated Manufacturers of Electrical Supplies

MILWAUKEE, WISCONSIN

"BUILT BY THE MASTER BUILDER"

C-H

Instruments of Guaranteed Quality Assure Success in Radio

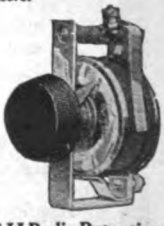


The C-H 4 Ohm Vernier Rheostat—*Perfect detector tube control. Also furnished without vernier for amplifier tube control.*

The C-H 30 Ohm Radio Rheostat—*For control of the ¼ ampere, "UV201A-C301A" type receiving tubes and the "UV199-C299" type.*

The C-H 125 Ohm Radio Rheostat—*The rheostat that makes it possible to use a 6V storage cell with the UV199 or C299 tubes.*

The C-H Variable Grid Leak—*Mounted on the tube socket—panel controlled. Adjustable for all grid condensers.*



The C-H Radio Potentiometer—*The potentiometer with the resistance unit that does not wear and cannot be displaced under constant usage.*

CUTLER-HAMMER

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Just like being there yourself

JUST like being in the same room—when your favorite violinist plays. You miss none of the wizardry of his art, if you listen-in with Murdock Radio Phones. You get it all—the rich resonance of the high and low notes and the subtle shading of the softer tones. Everything is reproduced clearly and with wonderful volume.

Perfect construction and diaphragm adjustment the reasons

The powerful magnets in the Murdock build up volume signals—and the sensitive, perfectly adjusted diaphragms turn these into clear, natural tones.

The seating and clamping of the diaphragms is an outstanding feature of the Murdock. This adjustment prevents distortion due to vibration.

May be worn for hours without discomfort

The Murdock may be worn through a whole evening without fatigue. Ear caps are moulded to fit the ears and exclude outside noises. The improved flat headband is feather-weight and does not bind the head; and there are no screws to entangle the hair.

For 20 years Murdock has been making radio phones of high efficiency. Over 1,000,000 users have accepted the Murdock standard of quality and price as the best measure of radio phone value. Buy a Murdock today and test it out—if you want to get the best results from your receiving set. They are fully guaranteed.

SEND FOR FREE BOOKLET. Mail coupon to us and we will send you our helpful booklet, "The Ears Of Radio." It explains in detail the importance of radio phones to efficient radio reception.

MURDOCK MULTIPLE PLUG JACK. This effective plug jack permits the use of one to four 'phones at the same time. Get one.

Announcing the Murdock five tube Neutrodyne Set. (Illustrated above). See this new type at your dealer's. Wm. J. Murdock Company, 372 Washington Ave., Chelsea Mass., Branch Offices: Chicago and San Francisco.

Built, not assembled

Murdocks are made in a single unit, of superior moulded insulation. Each part is fitted by one process into its proper place. They are moulded together—assuring firmness, strength and durability. And they can't get out of adjustment.

MURDOCK RADIO PHONES

Standard since 1904

WM. J. MURDOCK CO.
372 Washington Avenue,
Chelsea, Mass.

Gentlemen: Please send me, without obligation, your free booklet, "The Ears Of Radio."

Name.....

City.....

State.....

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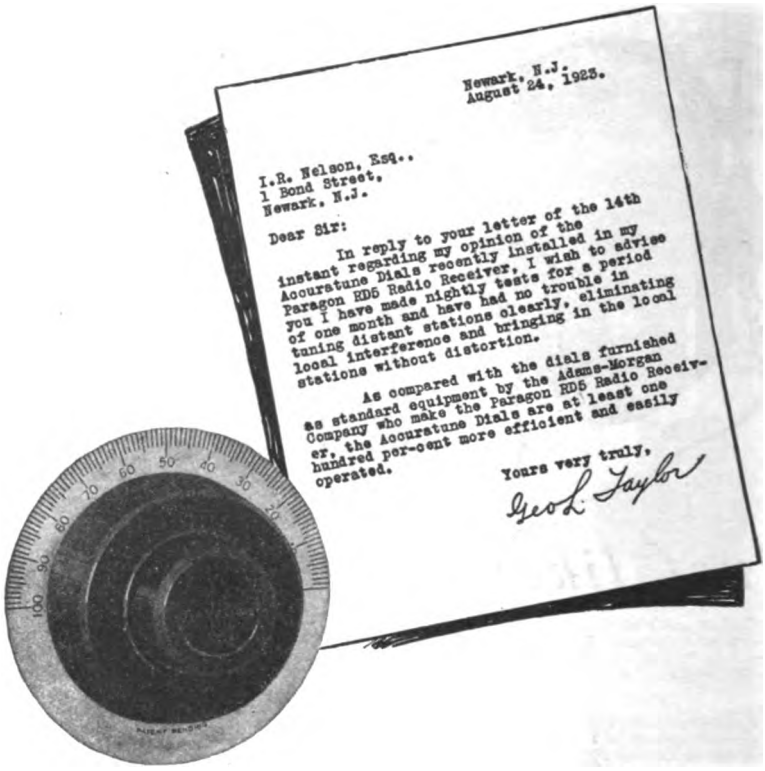
Newark, N.J.
August 24, 1923.
I.R. Nelson, Esq..
1 Bond Street,
Newark, N.J.
Dear Sir:
In reply to your letter of the 14th instant regarding my opinion of the Accuratune Dials recently installed in my Paragon RD5 Radio Receiver, I wish to advise you I have made nightly tests for a period of one month and have had no trouble in tuning distant stations clearly, eliminating local interference and bringing in the local stations without distortion.
As compared with the dials furnished as standard equipment by the Adams-Morgan Company who make the Paragon RD5 Radio Receiver, the Accuratune Dials are at least one hundred per-cent more efficient and easily operated.
Yours very truly,
Geo L. Taylor

--*from one who uses them*

Mr. Taylor says, "I have no trouble tuning distant stations! Accuratune dials are at least one hundred per cent efficient."

ACCURATUNE
Phonograph Attachment

Attaches instantly to the reproducing arm and converts your phonograph into a loud speaker. Permits the whole family to enjoy broadcast music.

$10.00

It is no little stunt to bring in a distant station, with all local and other disturbances in the air. But with an Accuratune fine adjustments are easy and the slightest turn of the micrometer knob will throw interferences out of the way and bring in the station you want CLEARLY.

The Accuratune is not a mere dial but an actual Micrometer Control more efficient than vernier condensers or any tuning device and far more simple to operate.

Designed for both coarse and precise tuning. Fits all standard condenser shafts. Price, $3.50.

MYDAR RADIO COMPANY
9-B Campbell Street ∴ Newark, N. J.

ACCURATUNE
MICROMETER CONTROLS

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Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

A. J. HAYNES
Assoc. Institute of Radio Engineers

NEW AND IMPROVED RADIO APPARATUS

Designed by A. J. Haynes

Mr. Haynes has made many valuable contributions to Radio. Featured in this advertisement are four pieces of apparatus designed and perfected by Mr. Haynes after extended research. Each of these items represents an invaluable contribution to the art of Radio.

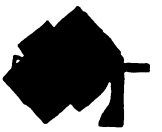
The Haynes Condenser

$3.50

Meets every requirement — extreme low minimum capacity and maximum capacity of exactly .00023 mfds. No other condenser is exactly like it—no other achieves exactly the right balance between perfect selectivity and over-critical adjustment.

The Haynes Bank Wound Vario-Coupler

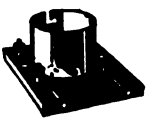
$4.35



Furnished with only the taps you actually use and just the right number of turns on the secondary. Bank winding provides 100% efficiency on higher broadcasting wave lengths.

Haynes-Griffin Socket

$1.00



Takes any standard base tube.

Dielectric losses have been reduced to a minimum in this new socket. Metal shell. Reinforced bakelite base.

Can be used for either base or panel mounting.

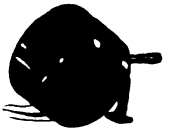
Haynes-Griffin Transformer

$4.25

An efficient intermediate wave radio frequency transformer giving a minimum of audio frequency amplification. Uniformly tuned to a limited wave length range, and providing a degree of quietness and stability heretofore unknown in transformers of this type. Haynes-Griffin Input Transformer also, $4.25.

Special Oscillator Coupler

$3.50



An indispensable adjunct for those who want the best results from the most advanced circuits.

Supplied with necessary leads already attached.

ASK FOR PRICE LIST OF NEUTRODYNE PARTS

Now available—price list of parts for a simplified and remarkably efficient neutrodyne receiver. This receiver embodies exceptional sensitivity, remarkable clarity of reproduction, and great ease of operation.

Mailed free to interested experimenters.

SEND FOR COMPLETE PRICE LIST

Located in New York City, the headquarters of the radio industry, Haynes-Griffin is always first in marketing new and improved apparatus.

Our new price list—just off the press—brings you up-to-date in radio. Everything that's new in radio included. Mailed anywhere upon receipt of 4c in stamps. Use the handy coupon.

Parcel Post Prepaid in U. S. anywhere east of the Mississippi River.

New York's Largest Radio Store

Haynes-Griffin
145 W. 45th St., New York City

Send me at once complete price list of new and improved radio apparatus. I enclose 4c in stamps for same.

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HAYNES-GRIFFIN RADIO SERVICE, Inc.
Mail Order Dept.—145 W. 45th ST., N. Y. City
Retail Store—41 W. 43rd ST., N. Y. City

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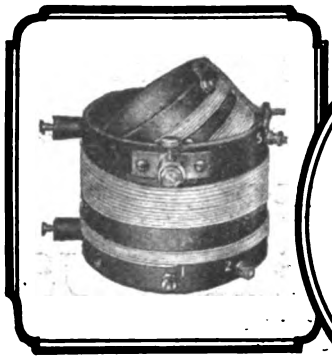

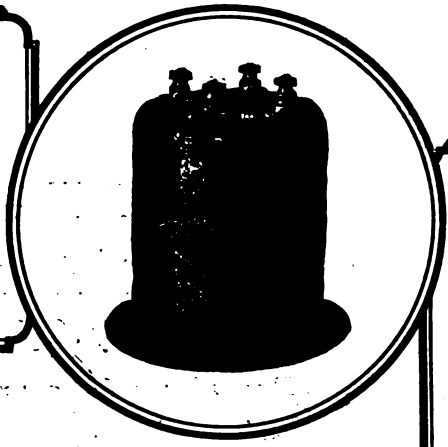

R-93— Specially Designed Coupler for Using Antenna. **$4.50**

***R-90**—Oscillator Coupler, complete, with mounting brackets, bank wound inductances and adjustable coupling coil with locking device. It covers a band of wave lengths from 150 to 800 meters and generates the maximum amount of current . . .* **$5.00**

R-91 — Intermediate Radio Frequency Transformer. Very sharply tuned and completely shielded **$6.50**

R-92—Special Transfer Coupler for Last Stage of Intermediate Frequency. Very sharply tuned and completely shielded. **$7.50**

AT LAST! Intermediate Radio Frequency Transformers

YOU can construct a Super Heterodyne Receiver with the assurance that you will possess the "last word" in Radio Reception. You can log each station and later single it out again with the same dial setting. List your stations in phone book style. Musical reception of crystal clarity, loud speaker volume and minimum interference.

The Branston Special Transformer is not an adaption, it was specially designed for this specific purpose. Rigorous tests prove it greatly superior to anything available prior to this announcement.

Our publication "SUPER HETERODYNE CONSTRUCTION," makes it possible for the amateur to construct a complete and efficient Super Heterodyne Receiver.

Add Miles and Smiles with Brdnston Standard Radio Parts

PROMPT DELIVERY AT YOUR DEALER'S OR WRITE FOR DETAILED INFORMATION

CHAS. A. BRANSTON, Inc.

811 Main Street, Buffalo, N. Y.

MANUFACTURERS OF

Branston Violet Ray High Frequency Generators

In Canada Chas. A. Branston, Ltd. Toronto, Ont.

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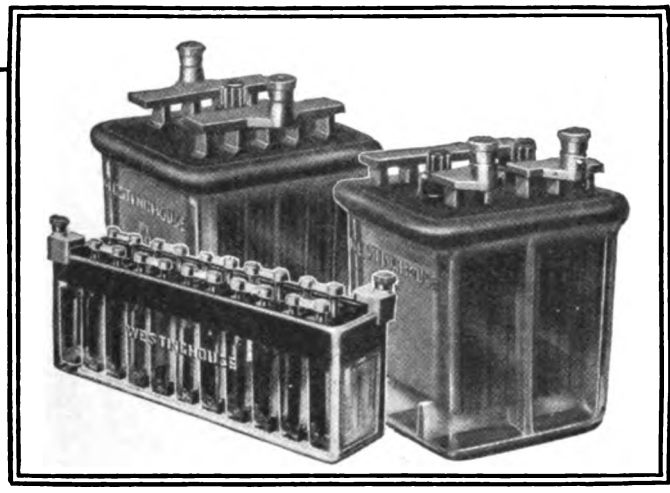

MAIL COUPON
for interesting facts about batteries

WHEN Westinghouse places an article on the market you can depend on it for highest efficiency. Westinghouse Radio Batteries are made with the most careful consideration of every factor that enters radio broadcast transmission and reception. Built for full-powered and even-powered current delivery; for long sustained voltage; for ample capacity; for utmost quiet; for long life; for economy. Nothing but the very best is good enough in the construction or equipment of an instrument so sensitive as a radio set. Don't be satisfied with anything less than Westinghouse Radio Batteries.

Westinghouse CRYSTALCASE Radio Batteries have one-piece clear glass cases. Solid glass cell partitions and high glass plate rests. Thoroughly insulated against current leakage. They hold their charge long. Last indefinitely and can be easily recharged innumerable times. "A" Batteries in 2, 4 and 6 volt sizes. "B" Batteries in 22-volt units. Regular type 22-MG-2; quadruple capacity 22-LG-2. "C" Batteries in 6-volt units.

WESTINGHOUSE UNION BATTERY CO.
Swissvale, Pa.

WESTINGHOUSE

RADIO
"A," "B" and "C"
BATTERIES

Westinghouse Union Battery Co.
Swissvale, Pa.
Send me Westinghouse Radio Battery Folder A-3-C.

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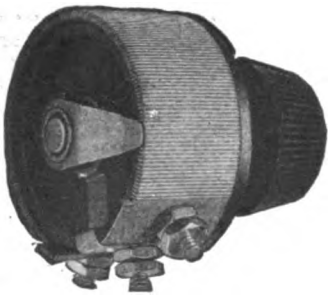
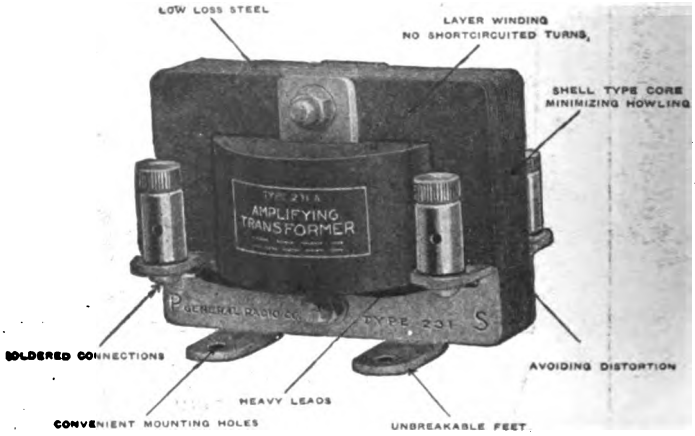
Amplification— undistorted

"Products of Proven Merit"

Type 247-H Condenser
Price $5.00



Type 301 Rheostat
Price $1.25



Type 231-A Audio F A Transformer

The efficiency of a broadcast receiver is often destroyed by poor amplification—due to inferior transformers.

In buying transformers be sure to look well into the electrical and mechanical features, as well as appearance and price.

The features which have gained the GENERAL RADIO CO. Type 231-A Transformer its enviable position as a leader among Transformers are:

Low loss steel used in its core construction.
Layer winding prevents short circuiting of turns.
Air gaps in core avoid distortion.
Unbreakable feet with convenient mounting holes, make installation easier.
Soldered connections eliminate losses from poor contacts.

Not only has this Transformer a high amplification factor but the amplification is nearly uniform throughout the entire audio range—making it ***best for all stages.***

Turns Ratio 3.7 to 1 — Impedance Ratio 10 to 1

PRICE - - - - - - - $5.00

Carried in stock by all good radio dealers.
Write ***TODAY*** for Instructive Folder—"Quality Amplification" and Bulletin 917U.

General Radio Co.

Manufacturers of
ELECTRICAL AND RADIO LABORATORY APPARATUS

Massachusetts Ave. and Windsor St., Cambridge, Massachusetts

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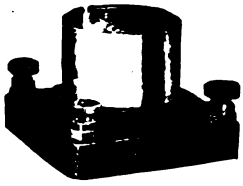
"The Loveliest Thing I've Ever Heard Over the Radio"—*Mary Garden*

Increased range and volume, as well as elimination of distortion, follow installation of Erla transformers. Reflex and Cascade types, $5



Erla sockets embody every improvement, with nickeled shell cast into Bakelite base, and tilted double contact springs. List $1

Only the most flawless reproduction, free from distortion and parasitic noises, could earn a tribute so unreserved from America's queen of song.

The exquisite tone quality and purity of Erla Duo-Reflex reception that appealed so irresistibly to Miss Garden is finding equally enthusiastic appreciation in the homes of super-critical radio lovers everywhere.

Not only in sheer tonal perfection, but in range and volume, have Erla Duo-Reflex receivers demonstrated decisive superiority. Tube for tube, they are the most powerful receivers known.

Complete Erla parts, including celebrated synchronizing radio and audio transformers that enable vacuum tubes to do triple duty, guarantee success to the amateur who "rolls his own." Easily understood blue prints guide every step.

Ask your dealer for free Erla Bulletin No. 20, giving latest Erla one, two and three-tube diagrams; or write direct, mentioning your dealer's name.

Electrical Research Laboratories, Dept R, Chicago

ERLA

Exclusive ability of Erla audio transformers to amplify three stages without distortion assures improvement in any receiving set. List $5

Erla two-way phone plugs hold phone tips securely without use of tools or cutting or changing phone tips in any way. List, 75c

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Selected Wood Produces Faithful Tones

LISTEN! The Sextette from Lucia. The living voices of the great artists — as if floating in through the window on wings of magic.

MUSIC MASTER," Radio's musical instrument, catches the softest tones, the most delicate shadings, the personality of each artist's voice—and the illusion of their presence in your home is perfect.

The wood amplifying bell of MUSIC MASTER eliminates blast, rattle and thin nasal tones and substitutes in their stead, full, clear, resonant tones—faithful and lifelike, a delight to the ear.

There is a scientific reason for the material, size and design of every part of MUSIC MASTER—developed and perfected by men who have spent more than a score of years in the study of sound reproduction.

Go to your dealer and let MUSIC MASTER speak for itself; or, better still, have one sent to your home to test and prove on your own set.

Dealers Everywhere

—

Connect in place of headphones. No batteries required. No adjustments.

MUSIC MASTER CORPORATION
Formerly General Radio Corporation
Makers and Distributors of High Grade Radio Apparatus
S. W. Corner 10th and Cherry Streets, Philadelphia
CHICAGO *PITTSBURGH*

14-inch Model, for the home $30
21-inch Model, for Concerts and Dancing . . $35

Music Master
RADIO REPRODUCER

Please refer to POPULAR RADIO *when answering advertisements.*

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FADA "ONE SIXTY" NEUTRODYNE RADIO RECEIVER

Simplicity

When a radio receiver is so simple that a little child can operate it as well as a grown person, then radio has reached a stage of development little short of perfection.

The Neutrodyne principle as applied to the FADA "One Sixty" has produced a radio receiver that is simplicity itself. Once the notations have been made of the dial settings of any stations, *anyone* can reset the dials in the given positions and listen to that station at will.

The FADA "One Sixty" four-tube Neutrodyne receiver is as selective, brings in distance and produces as great volume as any five-tube set. And, best of all, the FADA "One Sixty" can be depended upon to bring in most of the programs—local and far distant—on the loud speaker.

The pleasing design of the cabinet and its beautiful finish make it an ornament to any home. Price, exclusive of tubes, batteries and phones, $120.

F. A. D. ANDREA, INC., 1581 Jerome Avenue, New York City

FADA *Radio*

F. A. D. ANDREA INC. LICENSED BY RADIO MANUFACTURERS INC. NEUTRODYNE

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RADIO FREQUENCY AMPLIFICATION with the BALLANTINE VARIOTRANSFORMER

Get distance that everyone can enjoy

LET the whole family hear the announcer's "This is station ZYX, The Voice From 'Way off Yonder!" They can—by adding BALLANTINE Radio Frequency to your present outfit. Providing, of course, that you have a loud speaker. The voice or music will be clear and strong. And you'll find it easier to separate the various stations. Furthermore, squealing and distortions may be entirely eliminated.

Any standard set

One or more BALLANTINE units may be hooked in between any standard receiver and its audio amplifier—as shown above. Easy changes in wiring adapt it to regenerative, non-regenerative and even crystal sets. Besides, to reflex circuits the BALLANTINE brings the advantage of tuning each stage. Notable results have been obtained in the One-, Two-, and Three-Tube Reflexes as described in *Radio Broadcast*.

Complete radio frequency amplifier unit with socket and rheostat $15.00

Transformer only for panel or base $9.60

At dealers or postpaid

All wavelengths

Pure tones at maximum volume for the number of tubes employed are assured by the *continuously variable* feature of the BALLANTINE transformer. For, by turning only one knob, this instrument tunes sharply throughout the range of 200 to 600 meters. Pigtail connections and full shieldings prevent stray noises. Theory and details of construction will be furnished to those interested in our 25-page booklet, *Radio Frequency Amplification*.

A special service

Every user of BALLANTINE VARIOTRANSFORMERS is entitled to the experience and advice of the engineering staff of the Boonton Rubber Mfg. Co. Try the instrument first. Then, if there's anything you don't understand, write, giving full details of your complete outfit.

BOONTON RUBBER MFG. CO.
Pioneers in Bakelite Moulding

324 Fanny Road, Boonton, N. J.

RADIO FREQUENCY AMPLIFICATION with the BALLANTINE VARIOTRANSFORMER

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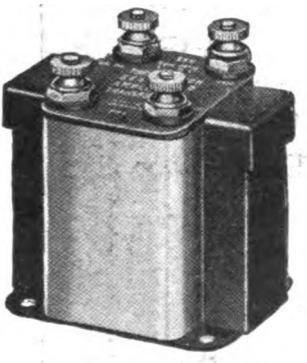

YOUR SET WILL BE A MUSICAL INSTRUMENT

WHEN YOU USE

THE THORDARSON SUPER

AUDIO FREQUENCY AMPLIFYING TRANSFORMER

Heretofore, amplifying transformer manufacturers have given too much attention to volume of amplification and have sacrificed the most important function of their transformers,—that of perfectly reproducing the broadcasted programs. Consequently many listeners in have complained about the musical qualities of radio reception.

No matter how good your phonograph, you could not expect to obtain good music from a poor record. Likewise, although your loud speaker be the best, you cannot expect to enjoy radio reception if the signals you put into it have been distorted in the process of amplification.

The new THORDARSON SUPER Audio Frequency Transformer was designed to correct the shortcomings of amplifying transformers of the past and embraces the following cardinal features:

(1) **Perfect reproduction of voice and instrument**
(2) **Even amplification over the entire musical range. (You will be surprised to hear the amazing reproduction of the bass notes.)**
(3) **Increase in volume to the extent that tonal purity will permit.**

This SUPER TRANSFORMER is the result of several months research work in the thoroughly equipped Thordarson laboratory and represents the culmination of twenty-eight years experience in manufacturing small transformers.

Such leading set manufacturers as the Colin B. Kennedy Company, Chicago Radio Laboratories Company (Zenith) and the Western Coil and Electric Company (Radiodyne) along with many others proclaim the merits of the THORDARSON SUPER TRANSFORMERS.

Install a pair of Thordarson Super Transformers now and your receiving set will be converted into a real musical instrument.

Even Amplification over the entire musical range

THORDARSON
ELECTRIC MFG. CO.

CHICAGO, ILLINOIS

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The CLEAR Loud Speaker!

HOW near the music sounds when it comes through the clear Herald! Just as if you were dining in a famous restaurant, and its orchestra were playing beside you.

That's the effect the Herald always gives. *Absolute clearness.* Because it is free from all blast and blur. Whether the number be music, lecture or news, the clear Herald is faithful to the performer.

THE Herald, like other good musical instruments, improves with age because of its laminated core, mica diaphragm and permanent magnet. It stands up under power without rattling. The adjustable diaphragm makes it possible to get the most out of a weak set. Height 30 inches. 6-foot cord. Price $30. Slightly more on Pacific Coast and in Canada. Write for folder and enclose your dealer's name.

Herald Electric Co., Inc., 113 Fourth Avenue, New York

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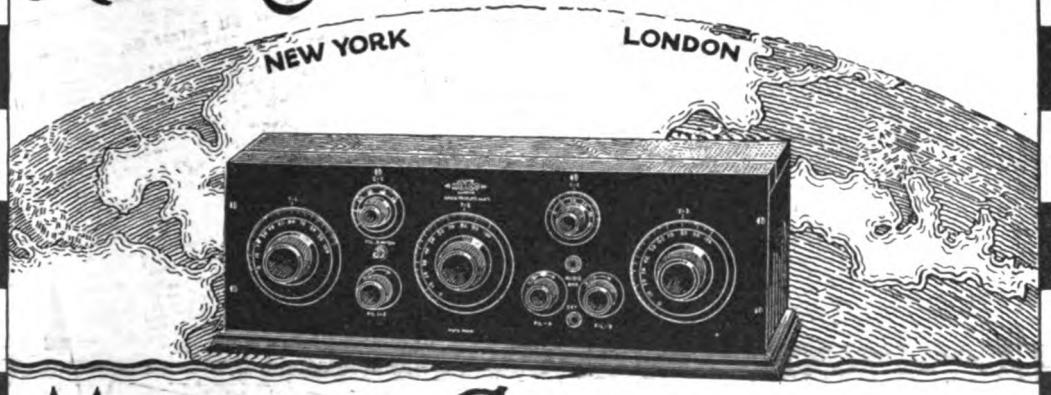
Now Links Two Continents!



MELCO-SUPREME

Tuned Radio-Frequency RECEIVER

Satisfies Every Radio Wish

AMSCO

Compensating Condenser

Rheostats and Potentiometers

Bakelite "Vernigrip" Dial

TO Consistently copy far west and coast stations is an achievement which only the ***Melco-Supreme*** can claim. Any set can occasionally get distance, but it remained for the ***Melco*** engineers to develop the now famous inductively tuned radio frequency receiver with neutralizing compensators, which duplicates its performances daily at the same dial readings.

Extreme Selectivity **Exceptional Clarity**
Simplicity of Operation **Perfect Control**

Each instrument is fully guaranteed

Write for complete descriptive literature

AMSCO PRODUCTS, Inc.

FAIRBANKS BUILDING
BROOME & LAFAYETTE STS. NEW YORK CITY

MELCO

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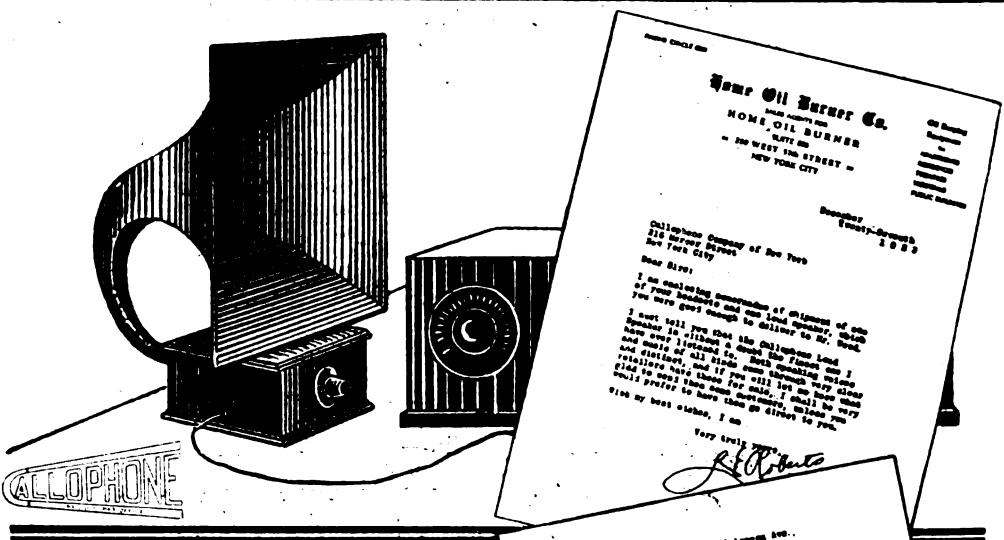

Read These Letters!

--the most critical find perfection in the CALLOPHONE

These people were "from Missouri" until they heard the Callophone. Its clear, natural tones convinced them and will convince you of the superiority of the Callophone over every other type of loud speaker on the market today—regardless of cost.

The Callophone is priced at $35.00—and worth it.

We ask you to try out the Callophone—if you are not entirely satisfied with its performance—return it, and your money will be refunded immediately.

Every Callophone owner is a "booster"—order yours now, and add your letter to the hundreds we now have. If your dealer doesn't stock the Callophone—send direct to:

THE CALLOPHONE COMPANY OF NEW YORK

216 Mercer Street ∴ New York

"Makers of Callophone Loud Talking Commercial Apparatus"

OUR GUARANTEE

The Callophone is tested under actual operating conditions and *sealed* before shipment. We will keep it in adjustment and repair free of charge, as long as this seal remains intact.

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Establishing a New Horizon for Radio!

MU-RAD RECEIVER
MA-15

STILL FURTHER beyond the accepted bounds of radio reception, this long-range MU-RAD Receiver MA-15 has extended the domain of radio entertainment. To the easy operation and high selectivity of the MU-RAD design, is added a still greater mastery of illimitable spaces together with pure, clear loud speaker volume. All this with only a handy 2 foot loop! The standard MU-RAD circuit of proven performance—two stages of audio and three stages of radio frequency amplification with detector. Adam Brown, hand-rubbed finished mahogany cabinet with voltmeter for quick reading of "A" and "B" battery conditions.

Guaranteed range with 2 foot loop~1000 miles

Write for Literature

MU-RAD LABORATORIES, INC.
809 FIFTH AVE. ASBURY PARK, NEW JERSEY

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5,000,000 Owners of Single Circuit Sets are waiting to Buy this Copp Vario-Selector

Copp Vario-selector
Patent Applied For

BECAUSE:

I. It will CHANGE any Single Circuit Set to a Double Circuit Set without re-wiring and without re-building. Simply connects to Antenna and ground and it is done.

II. ELIMINATES RE-RADIATION. This will be a great boon to Broadcast Stations and to all Owners of Broadcast Receiving Sets.

III. GIVES SELECTIVITY to a Single Circuit Set equal to any three circuit tuner, preserving the Single Circuit simplicity of tuning.

NOTE: The Copp Vario-Selector is NOT a Wave-Trap.

It is known that every Single Circuit Receiver re-radiates energy and causes interference in reception to every Receiving Set within a radius of several miles. Since there are so many Single Circuit Sets this has become a great hindrance to clear reception. A number of communities are trying to solve this situation by agreement and rules. It is certain that eventually The Supervision of the Radio Department will have to lay down the law for its solution.

With Copp Vario-Selector attached to Single Circuit Sets the problem is solved.

Think what a benefit this will be to ALL radio owners.

Think also what great benefit comes to the owner of the Single Circuit Set. No necessity to destroy the set and buy a new one. With Copp Vario-Selector he converts his set to a Double Circuit Tuner, he gets selectivity, he eliminates interference. He has benefited himself and all users of Radio Sets.

Copp Vario-Selector is sold in a Sealed Cabinet, beautifully finished, with engraved Bakelite Panel, and is guaranteed by us absolutely. Signed guarantee with every instrument.

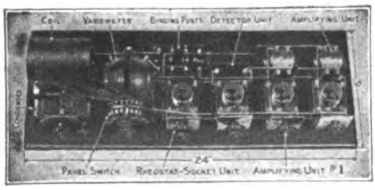
Jobbers and Dealers write us immediately for discounts. We can make quick deliveries now.

Price, $11.50

A-C ELECTRICAL MFG. CO. Dayton, Ohio

Makers of Electrical Devices for over 20 years

TUNED WAVE TRAP RADIO FREQUENCY RECEIVER



Built on famous Copp Circuit No. IV.
Efficient for all wave lengths from 200 to 700 meters.
Range up to 2000 miles.
Any person can build this set with A-C Dayton complete units.

$43.35

Units packed complete in one carton with wiring diagrams, photographs, instructions, etc., for complete installation.

See your dealer or write us direct. Circular on request.

THE A-C ELECTRICAL MFG. COMPANY, Dayton, Ohio

Makers of Electrical Devices for over 20 Years

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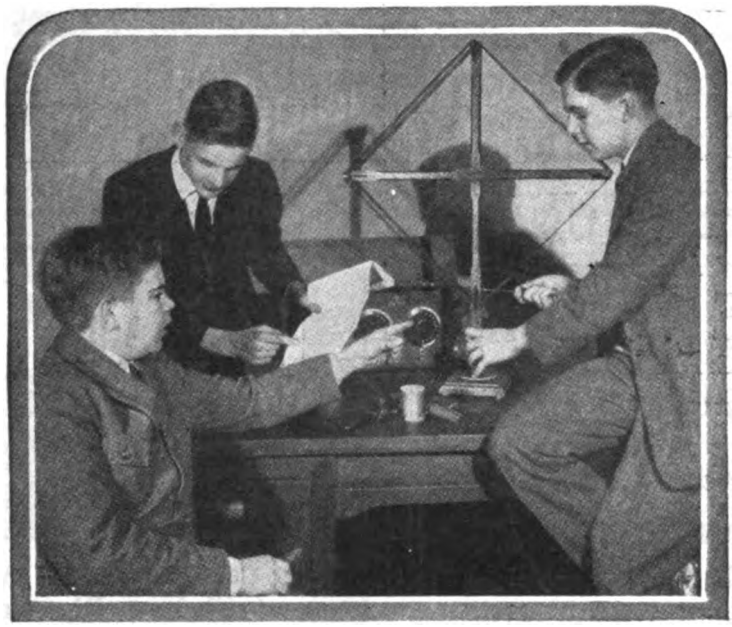

"WHY?"

THE childish persistency that keeps parents answering innumerable questions, does not cease with babyhood. Boys always want to know. But as they grow older they prefer to find out for themselves. And this very boy trait is largely responsible for the marvelous improvement in radio. From Armstrong down to the present day, the boyish desire to know "why" has led to new discoveries and inventions.

Call it curiosity, call it interest, or whatever you will—this universal boy characteristic is one of the greatest factors in the radio business. Not only does it keep manufacturers on their toes, keeping up with or ahead of the pack, but it keeps their plants running to supply the necessary radio equipment to satisfy boy wants. The radio pulse beats strong, because boys' dollars provide the impulse.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

is radio guide and instructor to 500,000 live-wire boys, averaging 15½ to 16 years old. Its stories, replete with thrilling radio adventures, fire their already active interest. Its articles deal with radio scientifically and authoritatively. Interest quickened, needs suggested, what more natural than to turn to the advertising columns for information on radio equipment?

Start this force working for you. Tell this army of boys about your product. Win their trade—more, win their loyalty. They'll boost your goods to the gang—to every "radiophan" of their acquaintance. Advertise where boys are sure to look—in their own respected magazine —THE AMERICAN BOY.

Copy reaching us by April 15th will appear in June.

THE SPRAGUE PUBLISHING COMPANY

(Member A.B.C.)

548 Lafayette Boulevard **Detroit, Michigan**

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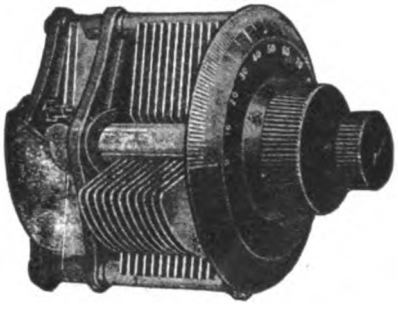
CHELSEA

SHARPER TUNING
AND
MORE VOLUME
with CHELSEA parts

Insist on getting a Chelsea

LOW LOSS
Condenser

Genuine bakelite insulation
Pigtail connection to rotor



#10—23 plate with Vernier, $4.50

ABSOLUTELY GUARANTEED

All prices include 3″ dial

#	8—43	plate	with vernier	$5.00
#	10—23	"	" "	$4.50
#	12—11	"	" "	$4.25

Without Vernier

#	3—43	plate	with dial	$3.25
#	4—23	"	" "	$3.00
#	5—11	"	" "	$2.75

Chelsea offers a complete line of parts and sets
At your dealers or write direct

CHELSEA RADIO COMPANY
183 SPRUCE STREET
Chelsea, Mass.

Supremacy Proven by Every Test!

The filament kontrol of infinite adjustment

FIL-KO-STAT

The SCIENTIFICALLY CORRECT RADIO RHEOSTAT for All Tubes!!

Can You "TUNE IN" With *Your* Rheostat?

THE Satisfaction of hearing DX stations you never heard before and of silent vacuum tube operation is yours when you install a **FIL-KO-STAT** in *any* hook-up, using *any* type of tube.

It means an additional and important *tuning unit*—for **FIL-KO-STAT** is more than a rheostat. Its critical control, spread over four turns of the knob, enables you to "tune in" DX stations that no other control on your set will get. And what's more it eliminates tube reradiation through micrometer vernier adjustment of filament heat (electronic flow.)

RADIO STORES CORPORATION
Sole International Distributors
HOME OFFICE, Dept. P. R.-4.
220 West 34th St., N.Y.

Full resistance 30 ohms

Price $2 AT YOUR DEALER IN CANADA $2.75

MADE BY DX INSTRUMENT CO. HARRISBURG, PA.

Unconditionally Guaranteed

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ATWATER KENT

Philadelphia

Selectivity — Distance — Volume and Ease of Operation

ANYONE can tune in a distant station without interference and obtain clear reception with an ATWATER KENT Receiving Set.

Selectivity — range — volume and simplicity of operation have made it the choice of families everywhere.

The clearness with which the ATWATER KENT Loud Speaker re-creates will give you a new conception of tonal fidelity.

Literature sent on request

ATWATER KENT MFG. CO.
4933 STENTON AVE., PHILA., PA.

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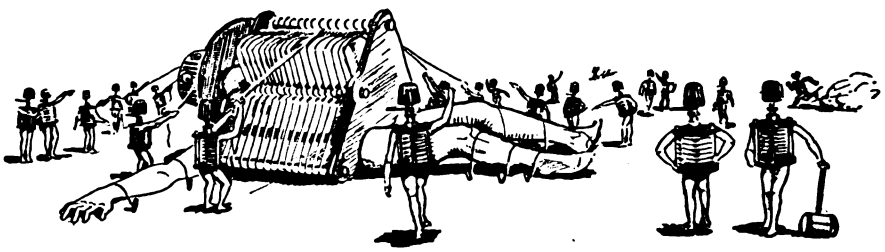


A Modern Gulliver and the Chelten Midgets

Like Gulliver of old—the Variable Condenser is kept within bounds by the tiny Chelten Midgets. These little Verniers with their 13 tiny plates can control the wanderings of your Condenser over this great land, causing it to bring to your listening ears either music—speech—bedtime stories—or other broadcasts.

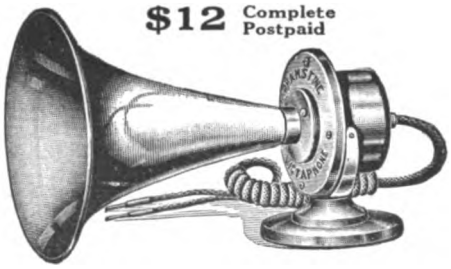
A turn of its tiny knob and a new station comes in clear and strong to entertain you. It gives that delicate adjustment so often necessary to change disagreeable sound into clear, distinct speech or beautiful music.

If you cannot get the Chelten Midget from your dealer, we will send you one upon receipt of money order for $1.50 and name of your distributor

CHELTEN ELECTRIC COMPANY

4863 STENTON AVENUE PHILADELPHIA

RHAMSTINE* VICTOPHONE



$12 Complete Postpaid

WITH HORN AND BASE

This is a new Rhamstine* Product—combining the popular Victophone with an attractive horn and swivel base. It is a unit which is original in design, neat in appearance, and in connection with the adjustable Victophone, gives remarkable volume.

All parts are nickel plated and polished.

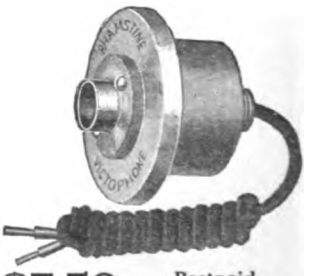
You will be satisfied with a Victophone and Horn. Order yours today.

RHAMSTINE* VICTOPHONE

For All Phonographs and Loud Speaking Horns

In addition to the large diaphragm used in the Victophone, every other detail has been given the closest attention. When incorporated with your phonograph or horn, it will reproduce with the utmost volume and purest tone. No battery required to operate it. Your money back if not satisfied.

It can be furnished to fit all phonographs—the Standard Type fits the Victrola, Columbia, Jewett or Sonora. Specify make of phonograph when ordering.



$7.50 Postpaid Complete with Cord

Order the New Victophone and test it before buying any other loud speaker

Manufactured by

J. THOS. RHAMSTINE*

Woodbridge at Beaubien Detroit, Mich.

***Maker of Radio and Electrical Products**

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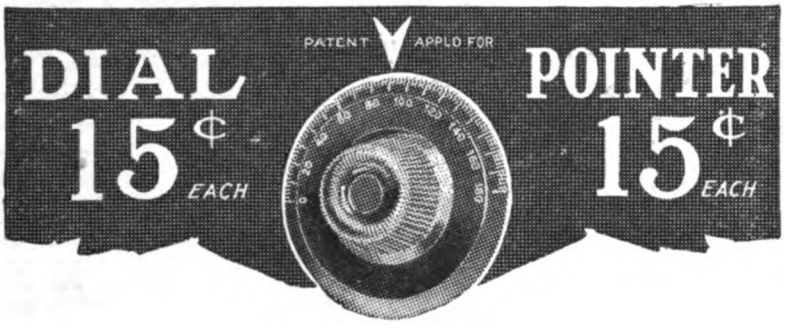
MARLE



A Metal Arrow Dial Pointer

VERY worth while refinement for your set. These raised metal arrow-pointers simplify dial setting and add a great deal to the workmanlike, "professional" appearance of your set. Easily attached to panels of any thickness—just drill a small hole, insert, and tighten screw in rear of panel. Does not in any way affect the efficiency of your set but makes its operation much easier. A lot of advantages for a very small amount.

Nickel plated raised arrow threaded for a No. 2-56 machine screw. Fits panels of any thickness.

At Your Dealer's

Marle Engineering Co.
Orange, New Jersey

Dealers: Write for details of our counter display card proposition. A real money-maker.

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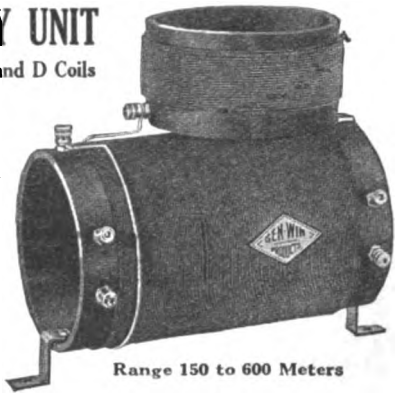
GEN-WIN
TRADE MARK
PRODUCTS

COCKADAY UNIT

Full Set A, B, C and D Coils

Made strictly in accordance to Mr. Cockaday's Specifications



Range 150 to 600 Meters

For 1 and 3 Tube Set
Price $4.50
Genuine XX Bakelite tubing wound with No. 18 single cotton covered wire.

For 5 Tube Set
Price $5.50
Best quality Radion hard rubber tubing ¼" wall wound with No. 18 double silk covered wire.

Guaranteed mechanically and electrically perfect. The outstanding features: Complete set of A, B, C and D Coils with beautifully knurled binding posts, eliminating loose end wires, insuring perfect contact and easier wiring. Made of the best quality material combined with expert workmanship. Distributed capacity or leakage and dielectric losses practically eliminated. Insures selectivity with maximum sensitivity and volume.

Two large blue prints and illustrated instructions together with list of parts necessary for building Cockaday Tuners furnished with each unit

Unconditionally Guaranteed to Give Absolute Satisfaction

At Your Dealer, Otherwise Shipped to You Postpaid

Dealers and Jobbers Write for Attractive Proposition

GENERAL RADIO WINDING CO. 214 FULTON ST. NEW YORK, N.Y.

91½% OF ALL RADIO TUBES ARE NEEDLESSLY DESTROYED

Accurate estimates show that less than 9 out of every 100 tubes give their full normal service and 91 are destroyed—usually burnt out from excess current.

The chances are 10 to 1 against you unless you use

RADECO SAFETY FUSES

These tube savers are now saving thousands of tubes. They are endorsed by the leading Radio Publications.

They slip on the filament terminals of the tube and in no way interfere with the operation of the set.

Price $0.50 each
(The cheapest insurance)

Install Radeco Safety Fuses now and whenever you buy a new tube insist on a Radeco Fuse to protect it.

Jobbers: We want a few live distributors to whom we can offer a very attractive proposition.

RADIO EQUIPMENT COMPANY

New England's Oldest Exclusive Radio House

20 STUART STREET **BOSTON, MASS.**

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Published for Every SUPERHETERODYNE *Experimenter*

In the service of hundreds of experimenters who are constructing or plan to build Superheterodynes, we have published a text book treating every problem involved in this remarkable circuit:

64 pages of valuable data collected after exhaustive investigations. Copiously illustrated. Shows how to build a Superheterodyne successfully. Gives full sized layouts, circuit blue prints, panel templates, etc.

The Superheterodyne Manual

Written by Victor Greiff, Member of the Institute of Radio Engineers, who has been associated in much of the radio development of the United States Navy, the Manual offers the only complete treatise on the subject. At the same time it is written so simply and clearly that any one who has a rudimentary knowledge of radio can easily comprehend every theory and application.

Order At Once! The Edition is Limited

Our First Edition of the Superheterodyne Manual is rapidly being sold out. Hundreds of copies are now being distributed with Receptrad Superheterodyne parts for the convenience of Receptrad builders. If you order promptly, however, you can secure the Manual—through your dealer, or by mail, postpaid. Price **$1.50**

Published by The Receptrad Press

That Receptrad has developed the finest Superheterodyne transformer built, is sufficient indication that its engineering personnel are properly qualified to prepare an authoritative Manual. Type 1716 transformers, range, 5,000 — 25,000 meters. Price $8.50

RADIO RECEPTOR CO.

INCORPORATED

57 BANK STREET **NEW YORK CITY**

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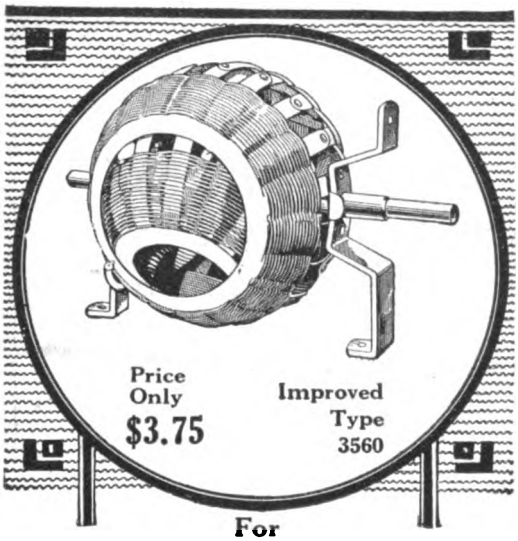


Price Only **$3.75**

Improved Type 3560

For

INDUCTANCE TUNING

the

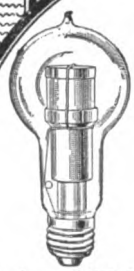
AMRAD

Basketball

Receiving circuits inductively tuned with BASKETBALL Variometers absolutely insure—

1. Greater receiving range
2. Perfect tone
3. Greater volume
4. Extreme selectivity, i. e. ability to "tune out" local broadcasting and get distant stations if desired.

Write today for Bulletin V describing the famous AMRAD Basketball



Improved AMRAD S-tube No. 4000 Price $10.00

For the Experimenter and Amateur, the AMRAD S-tube rectifier

No Filament to burn out. Operates CW Transmitters. Charges Storage "B" batteries. Other uses.

Write for new bulletin J-2 on S-tube; contains methods of connecting tubes to obtain various voltage, etc.

AMERICAN RADIO AND RESEARCH CORPORATION

Dept. P
Medford Hillside, Mass.

AMRAD

Speed Every Nut-Tight-with Spintite Wrenches

DON'T let any hard hook-up discourage you. Spintites enable you to work serenely and prevent leaky connections. Spintite's hexagon socket grips the nut solidly—the ebonized handle spins it up tightly—the hollow stem goes over projecting screws—and it's so easy to reach into cramped corners. What you'll save in time and grief on one hook-up will more than pay for Spintites. All sizes, from $\frac{3}{16}$" to $\frac{9}{16}$". Order a set today.

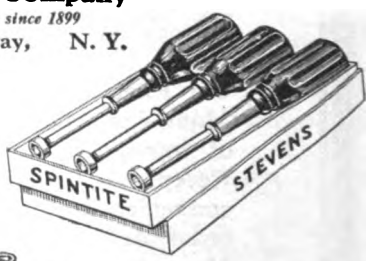
Send $1.00 for Set No. 71 with 3 most popular radio sizes

Stevens & Company

Toolsmiths since 1899

375 Broadway, N. Y.

Trade Name Registered



Send $3.50 for Professional Set No. 73—7 sizes, $\frac{3}{16}$" to $\frac{1}{2}$", in beautifully finished metal base

Stevens SPEED UP Tools

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"The Best That Money Can Buy"

"GOLD SEAL" HEADSETS

"GOLD SEAL" HEAD SETS are electrically and mechanically,—as well as from a radio standpoint,—as perfect as the highest-priced Head Set on the market,—yet, with all their perfection, they retail at only $6.00 for 2200 Ohm and $8.00 for 3200 Ohm.

The trade mark "DEVEAU" has stood for the highest quality in telephone apparatus for thirty years,—a guarantee that every known advantage in design and manufacturing has been taken into careful consideration.

Magnets are extra-heavy one-piece units; cups are of aluminum to keep down the weight but unlike other Head Sets, every exposed metal part of the set is finished in genuine 24-karat gold,—under a protective lacquer so that the finish will last for years; the terminals of each unit are concealed,—no contact possible with users' hands.

"DEVEAU GOLD SEAL" HEAD SETS are like a piece of fine jewelry in appearance, but with all the radio niceties that the most advanced radio enthusiast can desire. DEVEAU Units exactly match each other in tone,—each has maximum sensitivity and perfection of tone quality.

"DEVEAU GOLD SEAL" HEAD SETS are guaranteed to be electrically and mechanically perfect,—our Guarantee protects every purchaser.

STANLEY & PATTERSON 27 WARREN STREET
23 MURRAY STREET
NEW YORK CITY, U. S. A.

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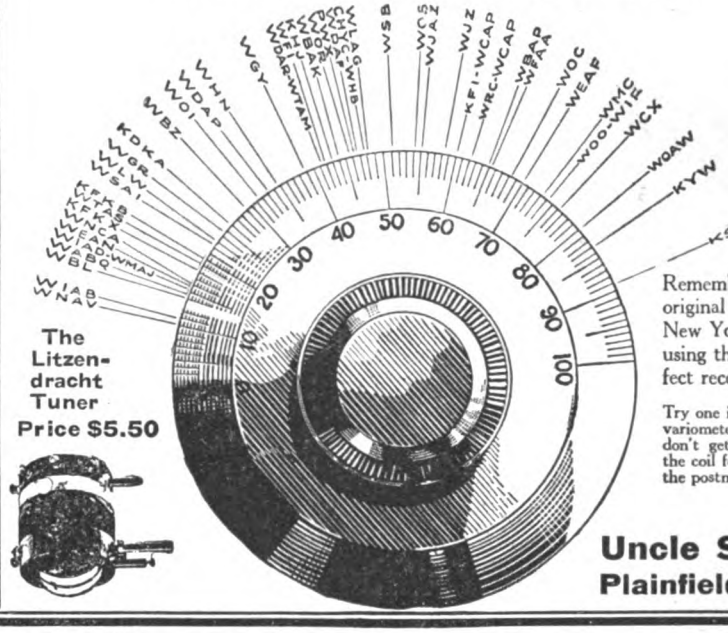
SELECTIVITY!

A Committee in Philadelphia hears 49 stations, from Cuba to Los Angeles, sign off in 8½ hours, (two tubes used)



The Litzendracht Tuner
Price $5.50

The UNCLE SAM

Licensed under Pat. Pending Rights "Home Built."

Master Tuning COIL Does the Trick

Remember the name—Uncle Sam—the original three circuit Tuner. In the recent New York Evening World DX tests a set using this coil was the only one with perfect record.

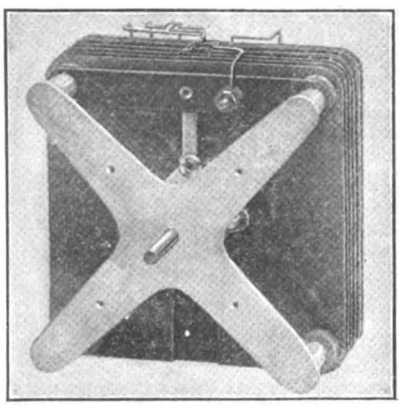
Try one in a new set, or use it in place of your variometer or variocoupler for 5 days. If you don't get the best results you ever had return the coil for refund. Send no money—just pay the postman.

Write for free hook-up.

Uncle Sam Electric Co.
Plainfield, New Jersey

Amplify the Telos way—

for clearer summertime reception!



One stage of Telos tuned R.F. amplifies 20 times—throughout its entire wave-length range! A second stage amplifies 20 times again.

—and by complete elimination of local oscillations, by making each stage entirely independent, Telos produces a clarity of reception that can be produced in no other way.

With summertime approaching, new thousands will want Telos selectivity, range and clarity. We cannot hope to supply them all. We *can* supply those who order at once—in time for summer-satisfaction.

Write your name and address on a postcard today—send it to Danziger-Jones, Inc., 25 Waverly Place, New York City—and you will receive a vitally interesting and important brochure that throws a new light on the entire subject of R. F. amplification!

Telos Radio

"—that the world may hear the world"

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BRISTOL SINGLE CONTROL RADIO RECEIVER

Most Simple to Operate

The set for those who want results with little effort. Anyone in the family can quickly learn to operate it because technicalities and guesswork are eliminated—One Control Dial does it all.

Does Not Interfere With Your Neighbor

Other close by reception is not disturbed when you tune in with this non-reradiating Receiving Set. It gives you a comfortable sensation of freedom to be able to change from one station to another knowing that you will not interfere with your neighbor's receiving.

Choice of Aerial or Loop

Where conditions make it difficult to install an outside aerial, as in congested sections of cities, good results can usually be had by using inside Loop. In fact, the directional feature of the Loop often brings in stations not possible with a stationary aerial.

Mounted in solid mahogany case with walnut finish, the Bristol Single Control Radio Receiver is handsome in appearance. The price is $190.00. Bulletin 3013-L describing this set will be mailed on request.

BRISTOL

TRADE MARK

AUDIOPHONE

REG. U. S. PAT. OFFICE

LOUD SPEAKER

This is known everywhere as the Loud Speaker with the quality tone. Not only is the tone natural and without mechanical distortion, but is sufficiently big in volume to be easily heard in a large room or all through the house. Comes to you ready to use—no auxiliary batteries are required.

Made in three models:

Audiophone Senior.....Price $32.50

Audiophone Junior.....Price 22.50

Baby Audiophone.....Price 12.50

THE BRISTOL COMPANY

WATERBURY, CONN., U. S. A.

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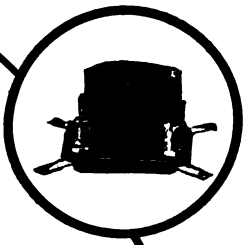
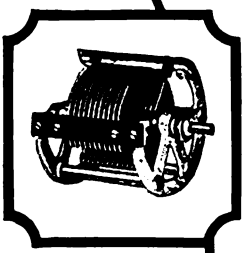
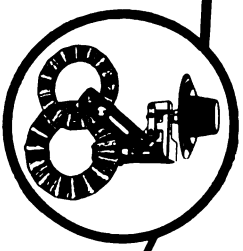
Genuine- E. T. Flewelling Radio Apparatus De Luxe



Flewelling Sockets are made for better reception. Wide spacing of contacts assures no capacity losses. Positive side "wiping" contacts mean positive connection with tubes. Made of extra high test bakelite in two sizes—Standard and 199. Price, **$1.00.**



Flewelling Condensers are ruggedly built. Made to give a world of service and stand up under more than ordinary abuse. Heavy 1-16 inch brass plates eliminate misalignment. Large ball bearings assure freedom of rotor. Electrical and mechanical efficiency exceptionally high. Made in two sizes—.005 mfd. 23 plate—**$7.00**; .0025 mfd. 11 plate—**$6.00.**



Flewelling Tuners make use of the most efficient basket weave coil windings with a micrometer coupling control. Dielectrics are eliminated from the coil field. Coils are interchangeable. However a wide wave band can be covered with one set of coils. Tuner complete with bakelite dial, **$8.00.**

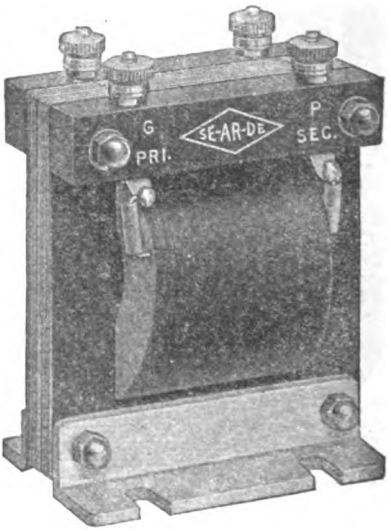
Genuine E. T. Flewelling parts are manufactured exclusively by

At Your Dealers or Direct

BUELL MANUFACTURING COMPANY
2979 Cottage Grove Avenue
CHICAGO

SE-AR-DE

HERE IS A WINNER



SE-AR-DE
Amplifying Transformer
Turn Ratio 4-1

20% louder signals with less distortion than any transformer on the market.

Large! But oh boy, you should send for copy of the amplification curve.

Price $5.00

R. MITCHELL CO.
255 Atlantic Ave. Boston, Mass.
EXPORT OFFICE
44 Whitehall Street New York
PACIFIC COAST OFFICE
Mission Street San Francisco, Cal.

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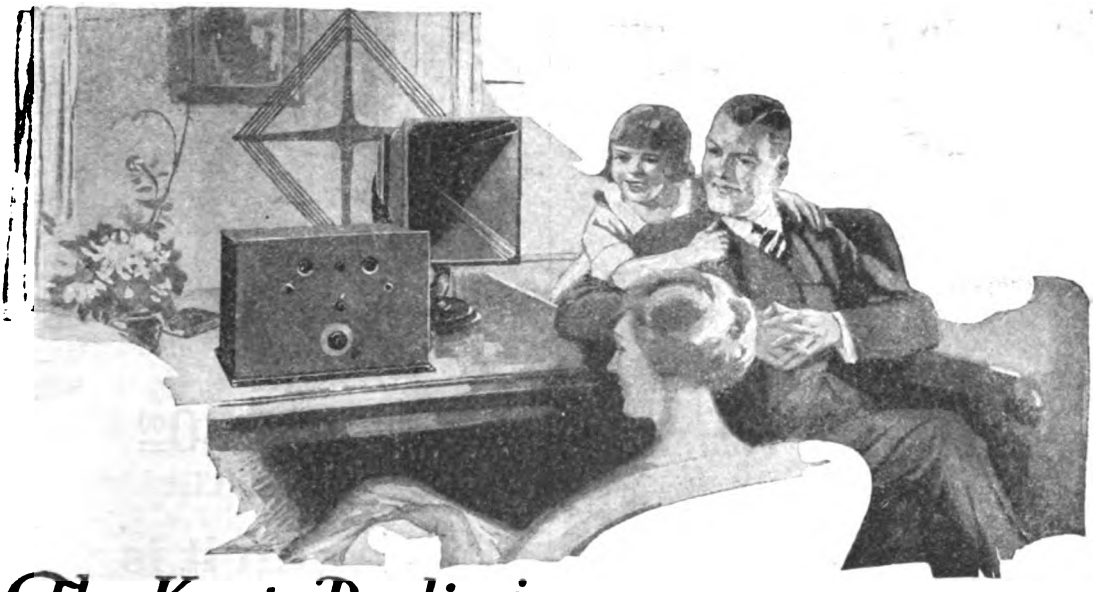


The Key to Radio is— Amplification without Distortion

THE key that unlocks the door to radio, with all its mysterious thrills and pleasures, is Amplification. Amplification builds up the tiny sound waves that come in to your receiving set, making them loud enough for you to hear and enjoy. Sounds that would otherwise be faint and unintelligible are transformed by amplification into—a concert in a far away city or a bedtime story, or the latest news.

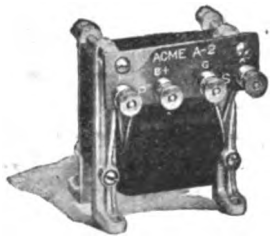
The danger of distortion

BUT in amplifying these sounds they must not be distorted. Distortion blurs the quality of the sound and makes squeals and howls out of broadcasting that should be clear and distinct. It is of utmost importance to use amplifying transformers that will amplify without distorting the sound.

How to get amplification without distortion

THE Acme Apparatus Co., specialists in the manufacture of transformers, have perfected two transformers which are famous among radio owners for giving the greatest amplification without distortion.

The Acme R-2 (also R-3 and R-4) Radio Frequency Amplifying Transformer builds up the incoming radio energy so that your detector will act. This gives added distance.



THE Acme A-2 Transformer (shown above) and Acme R-2, R-3, and R-4 Radio Frequency Transformers sell for $5 each at radio and electrical stores. Your dealer will be glad to help you.

The Acme A-2 Audio Frequency Amplifying Transformer builds up the audio energy which comes from the detector. This gives greater volume of sound without distortion. To be sure of getting the greatest possible range and getting it "loud and clear" use these Acme Transformers.

Send for booklet

IN ORDER to get the best results, send for "Amplification Without Distortion"—an instructive and helpful book which not only explains exactly how to get the best results by proper amplification, but also contains a number of reliable wiring diagrams. It will help you build a set. Mail the coupon with 10 cents for your copy.

ACME APPARATUS COMPANY
Dept. 42, Cambridge, Mass., U. S. A.

ACME
~ for amplification

ACME APPARATUS COMPANY,
Dept. 42, Cambridge, Mass., U. S. A.
Gentlemen: I am enclosing 10 cents (U. S. stamps or coin) for a copy of your book, "Amplification Without Distortion."

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City.....State.....

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Now you can UNDERSTAND RADIO!

Know all about it—build and repair sets—explain the vacuum tube—operate a transmitter—be a radio expert!

1 VOLUME
514 PAGES

Compiled by
HARRY F. DART
E.E.

Formerly with the Western Electric Co., and U. S. Army Instructor of Radio.

***Technically Edited by* F. H. Doane**

30,000 ALREADY SOLD

Every question you can think of is answered in this remarkable book, the biggest dollar's worth in radio to-day. Over 30,000 homes rely on the I. C. S. Radio Handbook to take the mystery out of radio. Why experiment in the dark when you can quickly learn the things that insure success? Hundreds of illustrations and diagrams explain everything so you can get the most out of whatever receiver you build or buy.

It contains: Electrical terms and circuits, antennas, batteries, generators and motors, electron (vacuum) tubes, every receiving hook-up, radio and audio frequency amplification, broadcast and commercial transmitters and receivers, wave meters, super-regeneration, codes, license rules. Many other features.

A practical book. Written and edited by experienced engineers, in plain language. Something useful on every one of its 514 pages. The authority that covers every phase of radio, all under one cover in one book for one dollar. Don't spend another cent for parts, turn a dial or touch a tool until you have mailed $1 for this I. C. S. Radio Handbook.

Send $1 at once and get this 514-page I.C.S. Radio Handbook—the biggest value in radio to-day. Money back if not satisfied.

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I enclose One Dollar. Please send me—post-paid—the 514-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

Name.....

Address.....

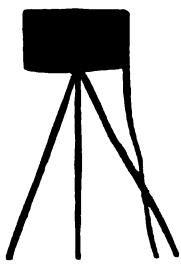
So human it is almost "uncanny!"

You doubt your ears when you first hear The Amplion.

It is so distinct and natural in its reproductions of voice and music, that it is often described as "almost uncanny."

The reason is that The Amplion, instead of being a head receiver fitted with a horn, is the adaption for radio of an electro-magnetic and acoustic instrument which for thirty years has been the standard loud-speaking device of the world's leading navies.

Requires no power amplifier, no battery. Attaches to regular phone connections.



Rubber bushings insulate the non-vibrating wooden horn and the reproducer from the metal sound conduit.

The special alloy diaphragm is adjustable to meet all conditions of receiving sets.

The Amplion comes in a variety of models, including portables and phonograph units.

In all the world there is nothing to equal The Amplion — *The World's Standard Loud Speaker.*

Ask your dealer for a demonstration

Patentees **ALFRED GRAHAM & CO.**

SIGNAL ELECTRIC MFG. COMPANY
Sole United States Distributors **Menominee, Michigan**

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For Better Radio Reception—

Freshman Products

GUARANTEED to be mechanically perfect, scientifically accurate and built for unusual durability. Used by discriminating manufacturers and amateurs all over the world, who realize that a radio set is only as good as each individual part.

The Standard Unit for Every Tube Set

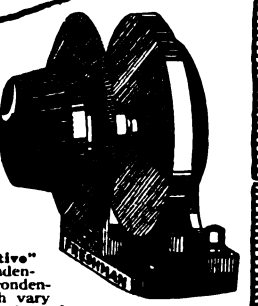
FRESHMAN
VARIABLE GRID LEAK and CONDENSER COMBINED

Permits you to adjust your circuit to any resistance you wish from zero to 10 megohms, in an unbroken range of 180 degrees.
It takes the place of a grid condenser, grid leak mounting and grid leak, and, in addition permits an adjustment to the correct amount of resistance.
It is the most compact, the most efficient, the most adaptable to all grid circuits, and the only one which is entirely sealed and always remains unaffected by any climatic conditions.

Base or Panel Type complete with .00025 or .0005 Freshman Condenser, $1.00. Either Type without condenser, $.75

"FRESHMAN SELECTIVE" Variable Condenser

For Transmission or Reception



The **"Freshman Selective"** Mercury Variable Condenser is the only variable condenser the plates of which vary in area, **an engineering feat never accomplished before.**

The "Freshman Selective" is attractively compact, quiet in operation and will withstand 8,000 volts without leakage or danger of short-circuiting.

.0003 MF (Equiv. to 17 pl.)
.0005 MF (Equiv. to 23 pl.)
.001 MF (Equiv. to 43 pl.)
} **$5 Each**

All moulded parts and dial of finest Bakelite.

Double Adjustable Freshman Crystal Detector

for base or panel mounting. When mounted on panel only the knob shows on the front. No more searching for the sensitive spot. Merely turn the knob as you would a dial, thus adjusting the crystal instead of the cats-whisker. Best for both Reflex and Crystal sets. Price.....$1.50

Guaranteed Capacities

The Condenser Sensation of Modern Radio
FRESHMAN NOISELESS TESTED MICA CONDENSER

Every Condenser is individually tested on high voltage for capacity, break-down and leakage. Every piece of Mica embodied in the Condenser is individually tested and examined. The new Style No. 101 is equipped with Freshman Soldering Terminals which allow 3 distinct connections with a very small amount of solder.

STYLE 100

Capacity	Each
.00005	$ .35
.0001	.35
.00015	.35
.0002	.35
.00025	.35
.0003	.35
.00035	$ .35
.0005	.35
.0006	.40
.0008	.40
.001	.40
.0015	.40

STYLE 101

Capacity	Each
.002	$ .40
.0025	.50
.003	.60
.0035	.70
.004	.75
.005	.75
.006	$ .75
.007	1.00
.008	1.00
.009	1.00
.01	1.00
.015	1.50

Freshman Vernier Dial

A Bakelite dial with Vernier adjustment. A small rubber tired wheel through the slot in the dial permits you to set the dial to the exact point and obtain the same dial setting every time. Just the thing for Neutrodyne and Heterodyne.

Price, 3 in., $1.00
Price, 4 in., $1.50

ANTENELLA

attached to any lighting socket eliminates the inconveniences in radio such as unsightly outdoor aerials, insulators, lightning arresters, lead-in, etc.

ANTENELLA

It is not only a real distance getter but also overcomes static annoyances. The complete and efficient aerial.

NO OUTSIDE WIRES NEEDED

ANTENELLA Price only $1.25

FRESHMAN FIX-O

A fixed Grid Leak Combination, 4 in 1

Freshman Condenser Leak Mounting
Freshman Grid Leak Safe-T Handle
} Price 65c

All megohms from 1/20 to 10 megohms.

Write for free diagrams of Neutrodyne, Tri Flex and Super Heterodyne Circuits.

At your dealers. Otherwise send purchase price and you will be supplied postpaid.

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Radio Condenser Products
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NEW YORK CITY

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TRADE MARK REG. U. S. PAT. OFF.

"We hereby guarantee Federal Standard Radio Products to be free from all mechanical and electrical defects . . . . and agree to replace at our expense, any unit or part which may prove defective."

This Federal guarantee is typical of the confidence reposed in Bakelite by the manufacturers of radio parts. For they have found in Bakelite a material which successfully meets all of the requirements for Radio insulation.

They have also found in Bakelite a combination of properties not possessed by any other material—properties which permit its adaptation to a wide range of manufactured articles in the radio industry. Mechanical strength, permanence of color, indifference to climatic or weather conditions and its durability under *all* conditions are only a few of the many valuable properties of this unique "Material of a Thousand Uses."

Write for a copy of our Radio Booklet K.

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Condensite
REDMANOL
are the registered Trade Marks for the Phenol Resin Products manufactured under patents owned by
BAKELITE CORPORATION

Send for our Radio Map

Enclose 10c to cover mailing cost and we will send you a large Radio Map which lists the call letters, wave length and location of every broadcasting station in the world.

BAKELITE CORPORATION
247 Park Avenue, New York, N. Y.
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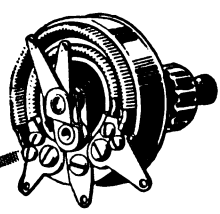
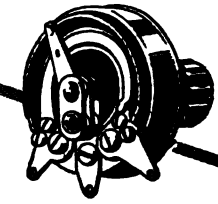
THE MATERIAL OF A THOUSAND USES



$3.00
All Types

$2.50



Standardize Now on These Quality Radio Parts

PREMIER

"DUOSTAT"

(TRADE MARK)

Two Rheostats in One

Windings independent of one another. Each operates one tube. Simplifies wiring. Base Bakelite molded, silver etched Dial, "NICHROME" wire windings. Made for all types of tubes. No. 12, two windings, each 7 ohms; No. 13, two windings, each 25 ohms; No. 14, two windings, each 40 ohms.

Price all types
$3.00

DOUBLE DISCONNECT

"POTENTIOMETER"

(TRADE MARK)

One outstanding feature is the double circuit breaker, which automatically disconnects A and B battery circuits, thus positively eliminating A battery drain (as heretofore present in all Potentiometers) and at the same time absolutely preventing accidental burning out tubes with B battery voltage. Genuine Nichrome wire wound; Bakelite base; Silver etched dial.

Price
250 ohm.....$2.50 500 ohm.....$3.00

SPECIAL ANNOUNCEMENT!

Do you know about the other quality Radio Parts made by Premier? Micrometer-Vario-Coupler, Jacks, Jiffy Switches, and "The Little Wonder" "Hegehog" Audio transformer.

Write for Free Bulletin No. 92, giving complete list of Premier Radio Parts, including the famous "MICROSTAT"

Ask for and insist on "Premier" Parts at Your Dealer

Premier Electric Company
3807 Ravenswood Ave., Chicago

19 years making Quality Electrical Apparatus

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PARAGON

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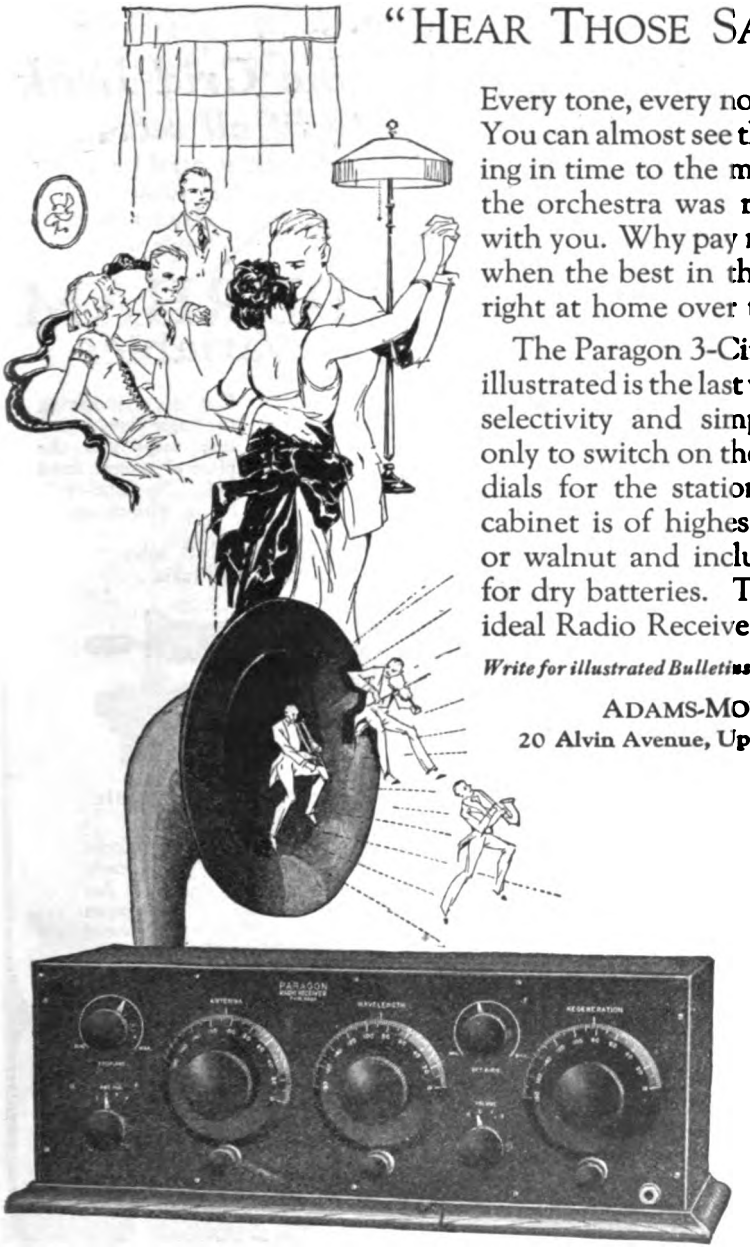
3-CIRCUIT RECEIVER



"HEAR THOSE SAXOPHONES!"

Every tone, every note clear and sweet. You can almost see the musicians swaying in time to the music. It's just as if the orchestra was right in the room with you. Why pay money to go dance when the best in the land can be had right at home over the radio?

The Paragon 3-Circuit Receiver here illustrated is the last word in sensitivity, selectivity and simplicity. You need only to switch on the tubes and set the dials for the station you want. The cabinet is of highest finish mahogany or walnut and includes compartment for dry batteries. The Paragon is the ideal Radio Receiver for the home.

Write for illustrated Bulletins of Paragon Radio Receivers

ADAMS-MORGAN CO.
20 Alvin Avenue, Upper Montclair, N. J.

PARAGON MODEL
RB—2
PRICE $135.00

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Morrison

Loud Speaker

Morrison

is a name identified with all that is fine in a loud speaking unit—for phonographs and horns.

Everywhere, those who appreciate really good radio, know they can depend on Morrison to bring out, consistently, the very best in radio reception.

These are the Reasons

Morrison Loud Speakers are manufactured by skilled radio workers in a laboratory ideally equipped.

Quality is never sacrificed—either in material or workmanship.

Every unit is triply tested before shipment.

Thus Morrison Loud Speaker maintains its front rank in the field of radio.

Nickel Plated Model

$10.00

Complete with a five foot cord

Send for an illustrated descriptive catalog.

Distributors

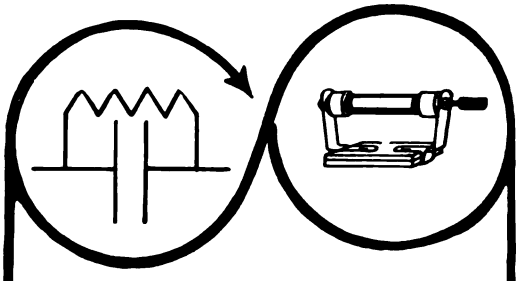
There are several territories still available. We are interested in securing proper representation.

Jobbers—Dealers

Our plan of merchandising has been profitable to many jobbers and dealers—if you are interested write or wire for details.

Morrison Laboratories Inc.

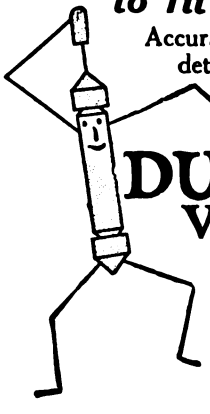
345 Jefferson Ave., E., Detroit, Mich.



Only

Variable Grid Leak

to fit all sets

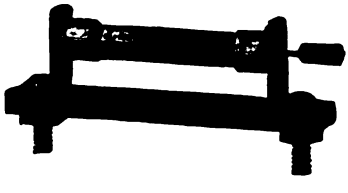


Accurat econtrol for every detector tube in the land now possible with

DURHAM Variables

Cartridge style, having one-finger plunger control, snaps into the place of present fixed leak. No panel-drilling or wire-change.

No. 101 for storage batt. tubes:
No. 201A for dry cell tubes



Typical sets improved with DURHAM Variables

Radiolas	Grebe
Westinghouse	Kennedy
Crosley	Ace
Federal	Paragon
Eagle	Mu-rad

and all Neutrodynes

Only 75c at dealers; or 80c postpaid

Free folder "C" gives details. Get yours from dealer or write

Satisfaction Guaranteed

DURHAM & CO., *Inc.*

1936 Market St., Philadelphia

Dealers: Every detector tube needs a DURHAM—the easiest to install, use—and sell.

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PAUL REVERE

ON the eighteenth of April in 1775 two lanterns were hung in the tower of the Old North Church in Boston signaling to Paul Revere in Charlestown the movement of the hostile troops. Thus began the famous ride which will always live in our history.

Paul Revere's broadcasting, although romantic and spectacular, seems crude to us today. The death of a president, an earthquake in far-off Japan, and many other instances which history may deem fully as important are now flashed almost instantaneously to millions of homes.

Only one key is necessary to gain access to this wonder land of Radio. The key is satisfactory receiving apparatus.

HOLTZER-CABOT Headphones and Loud Speakers enable your receiving set to give its utmost in sensitiveness, volume and quality.

The fullest enjoyment of Radio is yours if you own HOLTZER-CABOT equipment.

Holtzer-Cabot Loud Speaker	**$25.00**
Loud Speaker Phonograph Attachment	**10.00**
No. 2 Universal Headphones	**9.50**
No. 4 National Headphones	**6.00**

Write for booklets explaining how the exclusive features of these instruments enable you to enjoy the wonders of Radio

THE HOLTZER-CABOT ELECTRIC CO.
125 Amory Street, **Boston, Mass.**
6161-65 South State Street, **Chicago, Ill.**
Department B-1

Holtzer-Cabot
BUSINESS ESTABLISHED 1875

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Como Duplex Transformers

(*Push-pull System*)

The best and biggest selling transformer in the field. Merit alone has done it! The *"Como Duplex" was first* and we are being copied continually by those who lack the skill and knowledge to create. Imitation is the sincerest form of flattery and lots of manufacturers are flattering us. Mr. Laurence M. Cockaday, famous designer of radio circuits, having the world's best transformers to choose from has specified "Como Duplex" in his new 4 circuit tuner. This should be a sufficient guarantee for anyone.

Price $12.50 per matched pair

"Como Duplex" system of amplification gives a maximum volume without distortion and tube noises.

May be added to your present amplifier giving you power amplification on the weak signals that more of the ordinary amplification would kill.

A copy of "How to Make a Power Amplifier" is yours for the asking

COMO APPARATUS COMPANY, 446 Tremont St., Boston, Mass.

INSIST ON NEW YORK COIL COMPANY'S PROVEN RADIO PRODUCTS

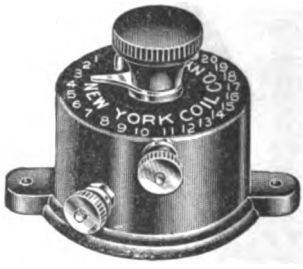
New York Variable Condenser with Vernier, 23 plate, $3.50, and 43 plate $4.50. Price includes dial and knob.

11 Plate.....	**$1.50**
23 Plate.....	**2.00**
43 Plate.....	**3.00**

Amplifying Distortionless Transformers

Correct for any tubes.

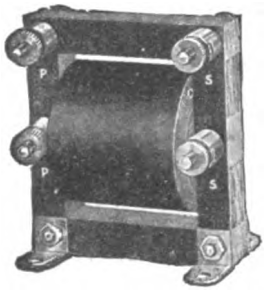
Price $4.00



The New York Variable Grid Leak

Easily tops the field in precision, permanency and efficiency.

Price $1.50



Mica Fixed Condensers

Of tested and permanent capacity, ranging from .0001 to .006, 35 cents to 75 cents, of **superior** quality.

.00025 with Leak Mountings, 45c

NEW YORK COIL COMPANY

338 Pearl Street **New York City, New York**

Pacific Coast—MARSHANK SALES CO., 1240 S. Main St., Los Angeles, Calif.

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Introducing—
A new Broadcast Receiver

Type RF-2, a receiving set of surpassing excellence is offered to the radio public.

Radio frequency amplification at its best is employed—a transformer-coupled tuned radio frequency circuit, with two stages of audio frequency amplification.

There are but two controls and tuning is extremely simple. Extraordinary sensitivity is combined with a high order of selectivity. Broadcast programs from far distant points are received with marked clarity and volume.

The assembly of instruments is encased in solid mahogany.

SEE IT! HEAR IT! COMPARE IT!

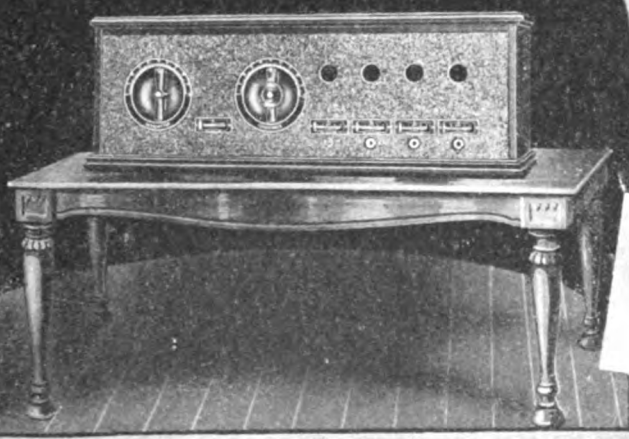
Ask your dealer

EISEMANN MAGNETO CORP.

William N. Shaw, President

46 Thirty-Third Street, Brooklyn, N. Y.

EISEMANN



Type RF-2
PRICE
$110.00

EISEMANN

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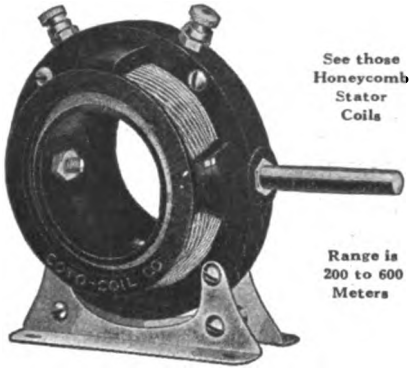
Coto

"Built First to Last"



See those Honeycomb Stator Coils

Range is 200 to 600 Meters

Every User More than Pleased!

Nation wide welcome by radio enthusiasts has proved that there is just one mistake you can make while buying this remarkable variometer. You can allow a dealer to switch you to one he wants to sell rather than let you have the popular Coto that is hard to get. Don't let him. Pound the counter if you must. INSIST!

Coto Moulded Variometer, Type 8000, $5.

The Silver Plated Air Condenser

Copper plates soldered firmly in place and SILVER PLATED. Losses of antenna energy are very low because of improved design and best rubber insulation. .001 Mfd. $6. .0005 Mfd. $5. .00025 Mfd. $4.50.

Where Loud Speaker Tones are Rich—

look for a really fine 5 to 1 turn ratio Audio Amplifying Transformer. Coto type 4000 has stood every test of wide use and can be depended upon for amplification that it's a treat to hear.

$5.

COTO COIL CO., 87 WILLARD AVE., PROVIDENCE, R. I.

Los Angeles, 329 Union League Bldg.
Minneapolis, Geo. F. Darling, 705 Plymouth Bldg.
Atlanta, C. P. Atkinson, Atlanta Trust Co. Bldg.
Canada, Perkins Electric Co., Ltd.
Montreal Toronto Winnipeg

DIAMOND DIAMOND

Your Money's Worth In Peppy Voltage

DIAMOND

RADIO PLATE "B BATTERIES"

No slackers. DIAMOND Batteries do a full night's work every night. Don't faint under the load, but come up fresh night after night. You get more out of DIAMONDS because so much more goes into them. The products of a responsible, well known electrical manufacturer. Guaranteed to satisfy. Get a DIAMOND Battery today. Each one in a separate carton stamped with the DIAMOND trade-mark.

If your dealer cannot supply you, order direct, C. O. D., naming your dealer

LIST PRICES

No. B-1, 22½ volts, $3.00, 5 binding posts in steps of 1½ volts.
No. B-2, 45 volts, $5.50, a longer life 45 volt battery, 5 positive taps.
No. B-16, 45 volts, $4.50, 5 taps from 16½ to 22½ volts.
No. B-4, 22½ volts, $1.75, for portable sets. 5 taps.
No. 3, Type C, 4½ volts, 70c, 3 taps.

DIAMOND ELECTRIC SPECIALTIES CORP.

102 SO. ORANGE AVE., NEWARK, N. J.

Dealers—Jobbers, Write for Proposition

DIAMOND DIAMOND

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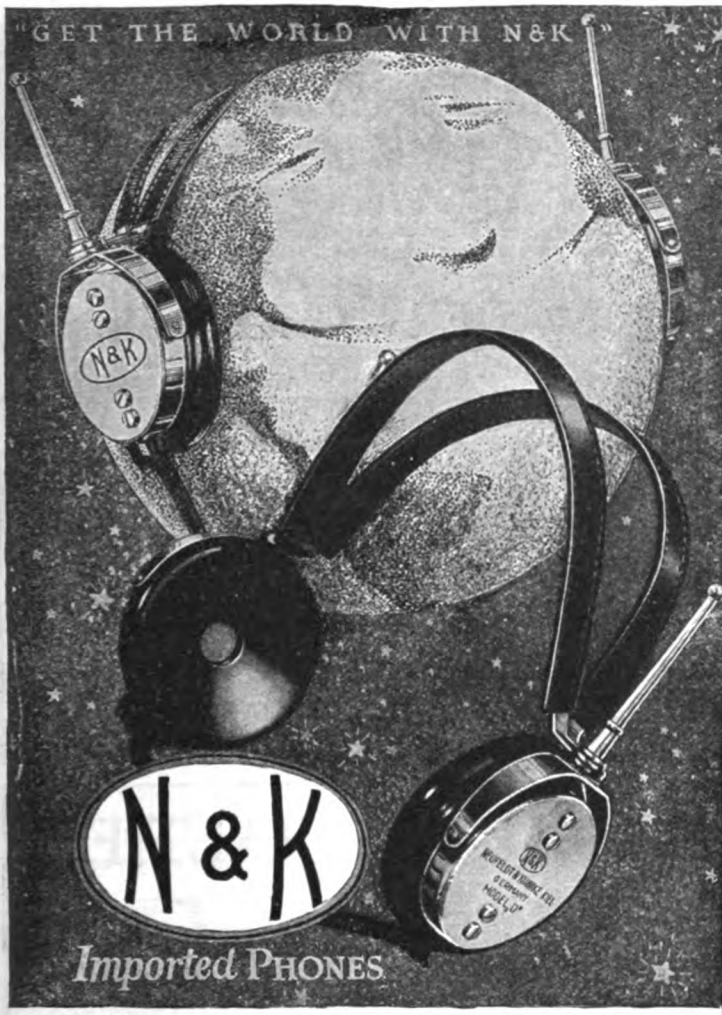

You shall be Sole Judge

A Most Unusual Offer

TEST N & K Phones on your radio set alongside *any other phones made.* If the N & K Phones do not reproduce both high and low tones more perfectly, if they do not give a clearer, more mellow tone, if they do not fit more comfortably on the head, send them back to the store within three days, and your money will be promptly refunded. No obligation whatsoever will be incurred. *You shall be the sole judge.* The N & K Head Set, Model D, 4000 ohms, is the imported head set that the radio "fans" are all talking about. Larger diaphragms. Nickeled brass sound chamber. Leather covered bands. $8.50 at leading stores. Ask for descriptive folder.

TH. GOLDSCHMIDT CORP., 15 WILLIAM STREET, DEPT. P4, NEW YORK

Any of the stores listed below or any other store displaying this advertisement will send you an N & K Head Set to make this trial.

Athol, Mass.	M. Steinert & Sons Co.
Atlanta	M. Rich & Bros. Co.
Baltimore	Hochschild, Kohn & Co.
	Little Joe Wiesenfeld Co.
	Joel Gutman & Co.
	Jones Electric Radio Co.
Bangor, Me.	M. Steinert & Sons Co.
Bloomfield, N. J.	United Cigar Stores
Boston	Shepard Stores
	M. Steinert & Sons Co.
	A. P. Merchant Co.
	Iver Johnson Sporting Goods Co.
Bridgeport	M. Steinert & Sons Co.
Brooklyn	Abraham & Straus
	Frederick Loeser & Co.
	A. I. Namm & Son
	Royal Eastern Elec. Sup. Co.
	20th Century Radio Corp.
	United Cigar Stores
Chicago	Marshall Field & Co.
	Radio Instrument Co. of Chicago
Cleveland	The May Company
	H. Lesser & Co.
Colorado Springs	Kaufman & Co., Inc.
	Teason Bros.
Dayton	The Anderson Piano Co.
Denver	Daniel & Fisher Stores Co.
Des Moines	Younker Brothers
Detroit	J. L. Hudson Co.
	Crowley, Milner Co.
	Detroit Electric Co.
East Orange, N. J.	United Cigar Store
Elmira	Barker, Rose & Clinton Co.
Fall River	M. Steinert & Sons Co.
Fitchburg	M. Steinert & Sons Co.
Harrisburg	Pomeroy's Inc.
Hartford	Sage, Allen & Co.
Houston	W. C. Munn Co.
Indianapolis	Alamo Sales Corp.
Jamaica, L. I.	Bangert Electric Co.
	Royal Eastern Electric Supply Co.
	United Cigar Store
Johnstown	Penn Traffic Co.
Kansas City	The Schmelzer Co.
	Western Radio Corp.
	J. W. Jenkins Sons Music Co.
Long Island City	Royal Eastern Electric Supply Co.
Los Angeles	Hamburger's
Lowell	M. Steinert & Sons Co.
	Bon Marche D. G. Co.
Memphis	Bry Block Mercantile Co.
	J. Goldsmith & Sons
Milwaukee	Gimbel Brothers
Minneapolis	L. S. Donaldson Co.
Newark, N. J.	L. Bamberger & Co.
New Haven	Edward Malley Co.
	M. Steinert & Sons Co.
New Orleans	D. H. Holmes Co.
New York City	Davega (11 stores)
	Gimbel Brothers
	John Wanamaker
	Herbert & Huesgen Co.
	United Cigar Stores (10 stores)
	David Killoch Co.
	Royal Eastern Elec. Supply Co.
	J. L. Lewis, Inc.
	Hanes-Zener Co.
	Haynes-Griffin Radio Service, Inc.
Oklahoma City	J. W. Jenkins Sons Music Co.
Omaha	Oakford Music Co.
	Richard M. Shlaes
Paterson, N. J.	Paterson Radio Co.
Pawtucket	M. Steinert & Sons Co.
Peoria	Block & Kuhl Co.
Philadelphia	Gimbel Brothers
	John Wanamaker
	Lit Brothers
	N. Snellenburg & Co.
Pittsburgh	Boggs & Buhl
	Kaufmann & Baer Co.
	Ludwig Hommel & Co.
Pittsfield, Mass.	Holden & Stone Co.
Portland, Me.	M. Steinert & Sons Co.
Portland, Ore.	Meier & Frank Company
Providence	The Outlet Co.
	M. Steinert & Sons Co.
Rochester	Kelman Electric Co.
San Francisco	The Emporium
Savannah	Leopold Adler
Seattle	Frederick & Nelson, Inc.
Sioux City	Davidson Bros. Co.
	Radio Exchange
Springfield, Mass.	M. Steinert & Sons Co.
St. Louis	Famous & Barr Co.
	Van-Ashe Radio Co.
St. Paul	Pioneer Electric Co.
Syracuse	Alexander Grant's Sons
Tulsa	J. W. Jenkins Sons Music Co.
Washington	Woodward & Lothrop
Waterbury	M. Steinert & Sons Co.
Worcester	M. Steinert & Sons Co.

Dealers: We authorize you to refund the price of any N & K Head Set returned under the conditions named in this ad. We will exchange or replace any sets that come back to you.

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No. 805
Height 17½ in.
Bell 6½ x 9½ in.
$20.00

One of 5 numbers ranging in price from $15.00 to $32.00 in choice of black or brown art finish. Send for circulars.

"MADERA" Die Cast WOOD

Gives Radio a New Voice

Did you ever stop to think that it is not the bow or the strings that give a violin its voice but the harmonious vibration of the wood body of the instrument? Imagine a violin made with a metal body! Then realize what an injury metal horns are doing to radio—just as metal horns held back the talking machine until wise men replaced them with wooden cabinets.

"MADERA Clearspeakers"

are made from artificial wood, cast from the original hardwood fiber, in steel dies, under a pressure of 12 tons to the sq. in. and 800 degrees of heat. This material is twice as dense as natural wood. Its acoustic properties are wonderful—resembling those of a rare old violin.

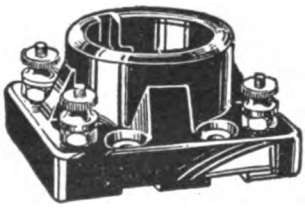
Madera Clearspeakers are fitted with a special Baldwin loudspeaker unit of great power and clearness. They are all ready to attach to any radio set adapted to loudspeaker service and are being used on many types of sets which could never use loudspeakers—even some of the better of the crystal outfits.

Order from Your Dealer If he does not carry the line write us, giving his name and address.

Circulars Free. Write right away so as not to lose an unnecessary day's delight with your radio.

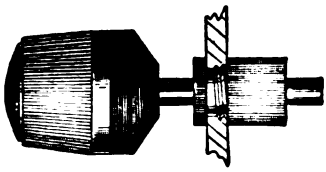
AMERICAN ART MACHE CO.
351 W. Austin Avenue ∴ ∴ ∴ Chicago

FLERON RADIO SPECIALTIES



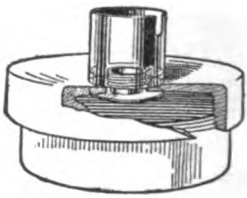
The Porcelain Sockets

Very carefully made. Brass parts nickeled. Black Glaze. Two sizes. Standard Bulbs and U. V. 199.
Each socket in a carton. 35c. each.



The Vernier Adjuster

The best adjuster on the market. Spring holds head away from dial when not in use. With slight adjustment spring can be made to hold head against dial if desired. Patented. 65c.



The Phono Adapter

Fits through the hole of the receiver cap and then slides on the phonograph tone arm. Fits Victor, Columbia, and others. Works perfectly. Only 35c. ea.

The Porcelain Insulators

Lowest power losses in the antenna. Dielectric absorption reduced to minimum because of very low phase difference of Fleron Porcelain. Very tough body. Solid Black Glaze. Seven sizes, 20c to $1.00. Each insulator in a separate carton.

The Stand-Off Insulator

Fills the much-needed requirement for a good strong looking and practical stand off insulator. Meets every requirement of the Board of Fire Underwriters. $1.25 each.

For Sale by all Good Jobbers and Dealers **M. M. FLERON & SON, Inc., 112 No. Broad St., Trenton, N. J.**

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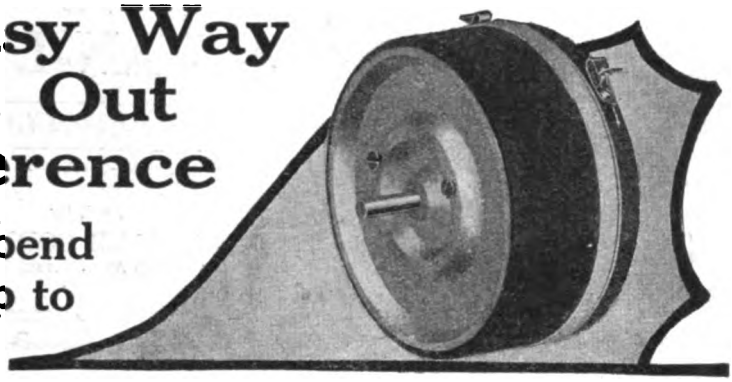
An Easy Way to Cut Out Interference

Add a Ferbend Wave Trap to Your Set



Why Listen to Three Stations at a Time?

Why rebuild and enlarge your set to the last pitch of refinement just to get better selectivity, when you can get a WAVE TRAP which, connected by two wires to your old set, will TRAP OUT the powerful waves from the interfering station, and leave the voice you want to hear just as "clear as a bell?"

The FERBEND is the original WAVE TRAP, designed and manufactured complete by us, after years of careful experimenting. Do not confuse it with imitations, hastily assembled from ordinary radio parts.

This Man Takes His Choice— Why Don't You?

Ferbend Electric Co.,
21 E. South Water St., Chicago.

I have installed the WAVE TRAP I purchased from you some time ago and given it a thorough try-out. There are five broadcasting stations in this city, four of them I can trap out by moving dial ten points, the other KFI, the most powerful one, I can silence by changing the dial twenty points. This station is heard on the Atlantic coast and Hawaiian Islands.

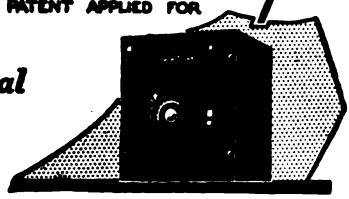
John F. Parsons,
109 N. Avenue 19,
Los Angeles, Calif.

FERBEND Wave Trap

TRADE MARK

PATENT APPLIED FOR

The Original Wave Filter



GUARANTEE

Every FERBEND WAVE TRAP is warranted to be of best materials, designed and manufactured complete by the Ferbend Electric Co. (not assembled from stock radio parts). When connected to any workable radio receiving set, and properly adjusted, according to directions, we guarantee that any interfering broadcasting station can be tuned out, while the station desired continues to be heard as before.

USE THIS COUPON —to double the pleasure from your RADIO SET

FERBEND ELECTRIC CO., 21 E. South Water St., Chicago, U. S. A.

You may send me a FERBEND WAVE TRAP, subject to your definite guarantee as printed at the left. I will pay the price which I have marked to the postman when he delivers the Wave Trap to me, and will also pay him the postage. (If remittance is sent with the coupon, then the Wave Trap comes postpaid. THE GUARANTEE APPLIES JUST THE SAME, EITHER WAY.)

☐ Check here for Ferbend Wave Trap, UNMOUNTED, $6.00
☐ Check here for Ferbend Wave Trap, MOUNTED, $8.50
☐ Check here for "Send me full information."

Name.....

Street.....

City.....

State.....

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A True-tone Non-Directional Ornamental Solid Mahogany Loud Speaker

Ask Your Dealer or Write Us Direct

The
VAN-LE
REPRODUCER
(Pat. App. for)

Mfd. by
VAN-LE CORP'N
100 Sip Ave., Jersey City N. J.

AN INTERESTING AND ATTRACTIVE PROPOSITION FOR DEALERS

WRITE FOR DETAILS

SUPERTRAN
Registered U. S. Patent Office
CERTIFIED!
Supertran Audio Transformers have been approved by the largest testing laboratory in the United States. They are "certified" by scientific measurements to be unequalled for volume, quality, and electrical efficiency.

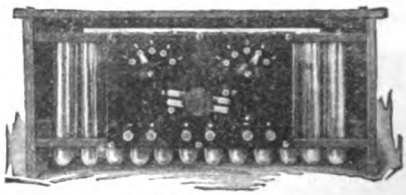
Price $6.00

These Transformers are especially designed for the Neutrodyne and Reflex circuits.

Can be used with any amplifying tube on the market with excellent results.

At your dealer—or direct by mail on receipt of purchase price

FORD MICA COMPANY, Inc.
33 East 8th St. New York



100 Volt Panel type

"I've found KIC-O 'B' batteries the most satisfactory"

A prominent New York engineer said the above. KIC-O batteries made good with professionals and novices. Alkaline type; won't sulphate or buckle. Life unlimited. Not harmed by short-circuiting, over charging, idleness. Panel switches give single cell variations. Recharge from any 110-volt A.C. line with small home rectifier. Charge lasts 3 to 6 months in detector or plate circuit.

Volts	Price, plain	With panels
22	$5.50	
32	7.25	$11.75
48	9.50	14.00
68	12.50	17.00
100	17.50	22.50
145	23.50	28.50

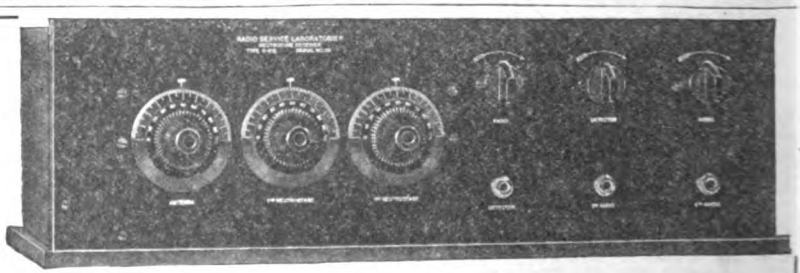
Unmounted Rectifier . . $1.00
Mounted Rectifier $2.50

GUARANTEE
Your money back on any KIC-O Battery if not satisfied within 30 days. Write for full information on "A" and "B" Batteries.

KIMLEY ELECTRIC COMPANY, Inc.
2667 MAIN STREET, BUFFALO, N. Y.

KIC-O Storage "B" Batteries—long service, low cost

"The Best Built Set in America" R-212



RADIO SERVICE LABORATORIES

Licensed by I. R. M., Inc., under Hazeltine Patents

Embodying the Hazeltine Neutrodyne circuit in an improved form as to neutralization, workmanship, quality, appearance and efficiency of operation.

Radio Service Laboratories, 1000 11th Ave. Asbury Park, N. J.

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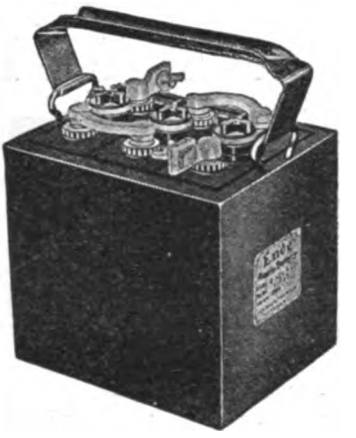

"A" Battery for six-volt tubes

When is a battery *cheap?*

A BATTERY that allows your soloist to be accompanied by a noise like a thunderstorm is never a cheap battery; because it's certain that you will be dissatisfied and soon supplant it with a good battery.

Obviously, a battery that does not last long is not a cheap battery.

The battery that is really cheap is the one that gives perfect service and gives it a long time; one that does not have to be recharged too frequently—a silent, long-lasting battery, steady and dependable.

Because they give such good service and such long service, you will find Exide Radio Batteries cheap in the true sense of the word. They may cost you more than some to start with, but long life and freedom from repairs make the last cost low. And the added enjoyment you get from your set, through clarity and lack of needless bother, will be priceless.

In replacing a worn-out battery or when buying a new set, be good to yourself and get an Exide.

Complete line of Exides for radio

There is a complete line of Exide Radio Batteries—batteries that give uniform filament current over a long period of discharge.

Apart from the 12-cell "B" battery there are three "A" batteries for whatever type tube you use. The Exide for 6-volt tubes gives full-powered, ungrudging service. It has extra-heavy plates and requires only occasional recharging. It comes in four sizes, of 25, 50, 100 and 150 ampere hours capacity.

The Exides for low-voltage tubes are midgets in size but giants in power. The 2-volt battery weighs only five pounds, has a single cell, and will heat the filament of WD-11 or other quarter-ampere tube for approximately 96 hours. The 4-volt "A" battery has 2 cells and will light the filament of UV-199 tube for 200 hours.

The dominant battery

On sea and on land the Exide plays an important role in the industrial life of the nation. In marine radio, Exide Batteries provide an indispensable store of emergency current. A majority of all government and commercial radio plants are equipped with Exides.

Exide Radio Batteries are sold by radio dealers and Exide Service Stations everywhere. Ask your dealer for booklets describing in detail the complete line of Exide Radio Batteries. Or write direct to us.

Exide
RADIO BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA
In Canada, Exide Batteries of Canada, Limited, 133-137 Dufferin Street, Toronto

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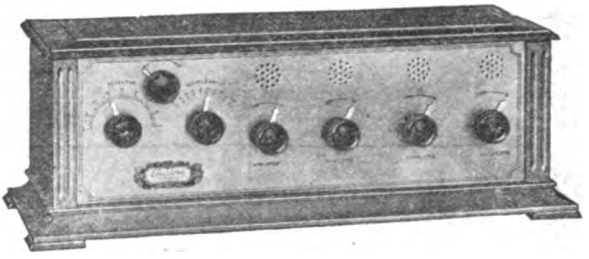
GOLDCREST RADIO RECEIVERS

Model 60
$60



With Gold Finished Panel

GOLDCREST Receivers have a distinctive, beautifully etched gold finished panel in a substantial mahogany cabinet. A set beautiful enough to be a valuable addition to the drawing room of the most fastidious.

GOLDCREST MODEL 60 is a four tube receiver consisting of one stage radio frequency, one detector and two stages audio frequency. This will assure consistent reception from 1000 to 1500 miles, loud speaker volume.

OUR PRICES are placed especially low because all parts are made within our own plant.

Model 60 . . . $60
Model 61 . . . $75
Solid Mahogany Console Model 62 . . $120

A SPECIAL OFFER

WE WANT YOU TO SEE, TRY AND BE CONVINCED. WRITE TODAY FOR FREE ILLUSTRATED CIRCULAR AND SPECIAL OFFER. IMMEDIATE SHIPMENT MADE ON ALL ORDERS

Dealers and Jobbers: Write and have your name placed on our mailing list. A new and interesting proposition for the asking.

THE CLEARTONE RADIO CO., Cincinnati, Ohio

WEIGHS ONLY 8 OZ.

The Scientific

THE PHONE IT TOOK A SOLID YEAR TO DESIGN

A $200,000.00 COMPANY stands squarely back of the guarantee on every *Scientific* headset

SEND NO MONEY!

20,000 TURNS EQUIVALENT TO 3,000 OHMS

Order TODAY by Postcard and Pay Postman on arrival

$2.95 POST-PAID

LOUD SPEAKER UNIT $1.95

We Guarantee The *Scientific* Headset to be the greatest value on the market. Try it for five days. If not satisfactory send it back and your money will be refunded immediately. Circular on request. Dealers wanted.

THE SCIENTIFIC ELECTRIC WORKS

98 Brookline Ave. DEPT. J BOSTON, MASS.

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MAGNAVOX

THE name Magnavox on a Radio Reproducer stands for the most careful workmanship, highest quality of material and also for a fundamental operating principle utterly distinct from that of ordinary "loud speakers."

The base of the new model Magnavox Reproducer R3, showing tone control

Important features now offered in Magnavox Radio—the Reproducer Supreme

THE Magnavox electro-dynamic principle obviates the need of any mechanical adjustment to regulate the air-gap or change the position of moving parts. This famous principle of operation permits the use of an electrical tone control.

This control directly affects the character of the electrical circuit which creates the sound, controlling the sensitivity of the instrument and also its volume of reproduction.

Moreover, this electrical control produces a great saving of current (already reduced in the new R3 and R2 to a maximum of .6 ampere) for, by its action, the current value can be reduced to a minimum of .1 ampere.

The new Magnavox electro-dynamic Radio Reproducers R3 and R2, in fact, are equipped with the first true sound controlling device ever designed. See them at your dealers and write us for catalog.

THE MAGNAVOX COMPANY
OAKLAND, CALIF.
New York Office: 370 Seventh Ave.
Perkins Electric Limited, Toronto, Montreal, Winnipeg, *Canadian Distributors*

4R

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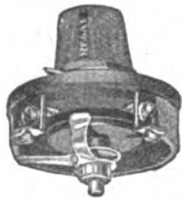
THREE Regal MASTERPIECES!

Perfect Contact Vernier Rheostat

For fine filament control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market.



Complete with Knob

6-Ohms.....**$1.25**
30-Ohms..... **1.25**

Fifteen Taps—But Only One Drill Hole Required!

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of holes. No more chipped panels. Complete with hard rubber Knob and Dial.
Type No. 162.....**$1.50**

Broadcast Tested, High Quality Audio Transformer

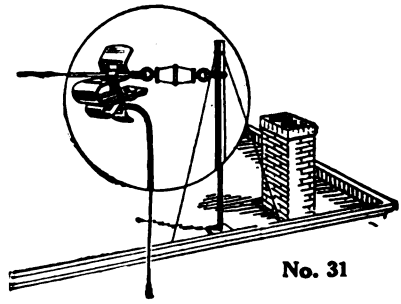
For clearness of tone, amplification of voice and music from near-by and distant broadcasting stations, Regals are unequaled by any Transformers on the market.

3½ to 1 Ratio...**$4.25**
5 to 1 Ratio... **4.50**

At all good dealers—otherwise write direct for complete descriptive folder No. 24, sending dealer's name.

AMERICAN SPECIALTY CO.
Bridgeport, Connecticut, U. S. A.

FAHNESTOCK'S
RADIO PRODUCTS



No. 31

The Antenna Connector

Snap larger connector over Antenna Wire; insert Lead-in Wire into smaller clip and a perfect connection is the result.

Improved Ground Clamp!

Equipped with Fahnestock Patent Wire Connectors Easily Attached.

No Soldering—For Radio Use Only.

Our name is stamped on all our products. None genuine without it.

At Your Dealers

FAHNESTOCK ELEC. CO.
Long Island City, New York

No Two Receivers Are Alike

Connect In Multiple and One Will Get Most Current

AJAX—MULTI—RADIO

Phone Plugs and Connectors
Allow One to Four Head Sets or Loud Speakers
ALWAYS IN SERIES

No. 18—For Jacks
No. 18A—For B Posts

Gives Equal Results to All. No Others Like AJAX—$1.75 Each.—Dealers or Direct.

Liberal Discounts on Complete Line to Dealers and Distributors

AJAX ELECTRIC SPECIALTY CO.
1926 Chestnut St. St. Louis

Amplify the MODERN *way!*

Modern "Push-Pull" Power Amplifying Transformers

More volume—less distortion—perfect reproduction of music or speech.

New bulletin of amplifier hook-ups and circuits using "Push-Pull" amplification, at your dealer's or sent free on request to us.

Modern "Reflex" Audio Transformers for all reflex circuits using crystal detectors. Will work satisfactorily with any standard Radio Frequency Transformer.

Modern standard Audio Transformers 4 to 1 ratio for all 2-step amplifiers and specially designed for use with Modern "Push-Pull" Transformers.

If your dealer can't supply you, write us giving his name

Modern Electric Mfg. Co. Toledo

The Modern Elec. Mfg. Co.
Dept. 704, Toledo, Ohio

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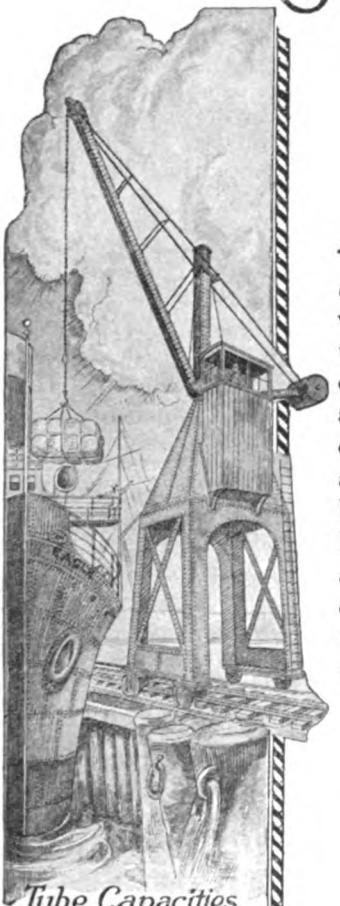
Eagle Neutrodyne Balanced! RADIO RECEIVER

ALL the uttermost resources of radio are yours to command with the remarkable *Eagle Neutrodyne Receiver.* Former difficulties with tuning, capacity effects, reradiation, and regeneration are gone. Far-distant stations are brought in clear and loud, as easily as a phonograph is operated. Tube capacities are balanced just as the power crane is balanced by its counterweight. Each Eagle Receiver is individually balanced and tested by a prominent radio expert. Backed by an excellent reputation. Guaranteed without reservation.

***

Licensed by Independent Radio Manufacturers, Inc., under Hazeltine Patent No. 1,450,080, dated March 27th, 1923, and other patents pending.

Write for Illustrated Leaflet



Tube Capacities **BALANCED**

Just as the Electric Crane Arm is Balanced

WE SOAR ABOVE
EAGLE RADIO COMPANY
NEWARK NEW JERSEY

18 Boyden Place

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Blueprints

"Improved" Cockaday 4-Circuit Tuner and Tuned-Radio-Frequency Receiver

SO great has been the demand for POPULAR RADIO's Blueprints of the "Improved" Cockaday 4-Circuit Tuner, that we have now prepared similar actual size Blueprints of the Non-Regenerative Tuned Radio-Frequency (neutrodyne) Receiver described in this issue.

EACH of these sets of Blueprints has been drafted by our own staff under Mr. Cockaday's personal supervision. They are full size, accurate, authoritative—and so simple to follow in all details that a novice can work from them without difficulty.

The two complete sets of **three** prints each, covering all constructional requirements for these two highly-efficient receivers, include an exact panel pattern, an actual size instrument layout, and a picture diagram of all parts **showing every wiring connection.**

With these actual size Blueprints you can drill your panel without taking a single measurement; you can arrange your instruments and parts in exactly their correct places without guess or hesitation—and you can connect all terminals without even knowing how to read a hook-up diagram.

To make these Blueprints available to all, they have been priced at the very low figure of only $1.10 postpaid for each complete set of three prints. The complete set of three prints on the "Improved" Cockaday 4-Circuit Tuner may be had at $1.10 postpaid. The complete set of three prints on the Non-Regenerative Tuned Radio-Frequency (neutrodyne) Receiver may also be had at the same price, $1.10 postpaid. Single prints (one sheet only) are not available, as the complete sets cannot be broken.

For your convenience two handy coupons are printed below—one for the Blueprints of the "Improved" Cockaday 4-Circuit Tuner, and one for the Blueprints of the Non-Regenerative Tuned Radio-Frequency (neutrodyne) Receiver. Simply fill out the coupon which calls for the set of Blueprints you want. Attach your remittance for $1.10, and the Blueprints will come to you by return mail.

If you wish **both** sets, fill out and mail **both** coupons with your check or money order for $2.20.

POPULAR RADIO, INC.

9 East 40th Street — Dept. 44 — New York City

POPULAR RADIO, Inc., Dept. 44
9 East 40th Street, New York City

Enclosed is $1.10 in full payment for a complete set of three Blueprints for the **"Improved" Cockaday 4-Circuit Tuner,** consisting of the following:

Exact panel pattern.
Actual size instrument layout.
Picture diagram of all parts (actual size) showing complete wiring.

Name.....

Address.....

.....

POPULAR RADIO, Inc., Dept. 44
9 East 40th Street, New York City

Enclosed is $1.10 in full payment for a complete set of three Blueprints for the **Non-Regenerative Tuned Radio-Frequency (neutrodyne) Receiver,** consisting of the following:

Exact panel pattern.
Actual size instrument layout.
Picture diagram of all parts (actual size) showing complete wiring.

Name.....

Address.....

.....

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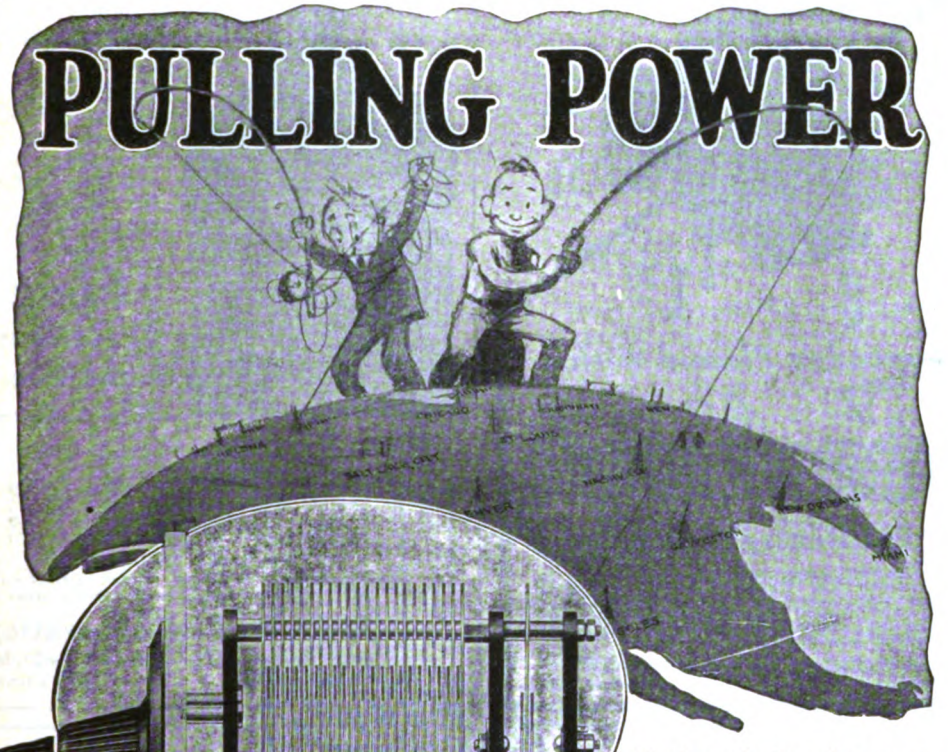
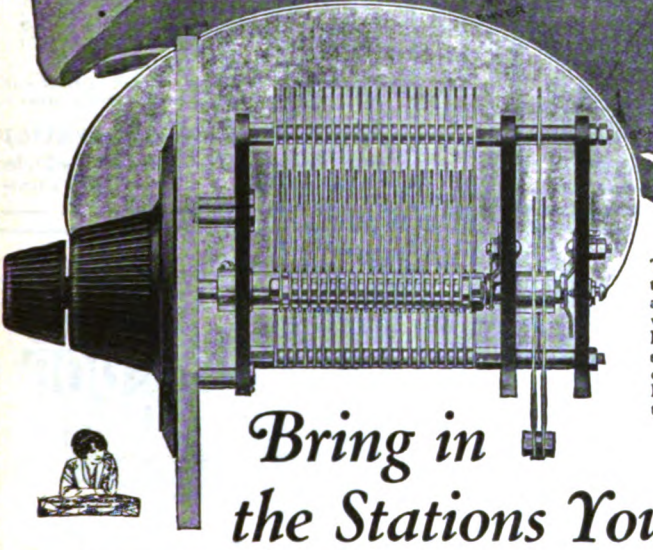
PULLING POWER





The heavy aluminum plates cannot touch. Large bearings assure long life and smooth operation. Three-plate vernier for extremely fine tuning. Solid Bakelite end pieces. Arranged for screw or soldered connections. Size of plates correct for maximum volume. Easy to mount. A master condenser that will last forever.

USE—*is the test*

Bring in the Stations You Want

THE decremeter type plates of the Kellogg variable condensers furnish the widest tuning range possible, as the increase or decrease in capacity is constant; dials calibrated in wave lengths can be used. This gives the fine tuning necessary where the greatest selectivity is desired.

In constructing a selective set the variable condensers play an important part in the degree of its selectivity. That is why we recommend using Kellogg.

Select Kellogg radio equipment and know you have the best. If your dealer does not handle Kellogg, communicate direct with us.

KELLOGG SWITCHBOARD & SUPPLY CO.

1066 West Adams Street, Chicago

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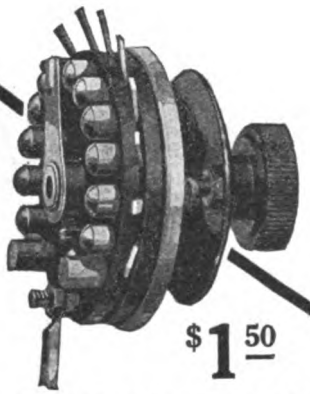


$1.50

Everybody's Pleased With a

Sterling

12 Point Rotary Switch

No more fumbling around with elusive wires and variocoupler taps. This 12 point switch adds to the appearance of the front of board contact points and makes it easy for you to solder variocoupler taps to its various terminals. May also be used with a voltmeter for reading voltage on individual tube filaments.

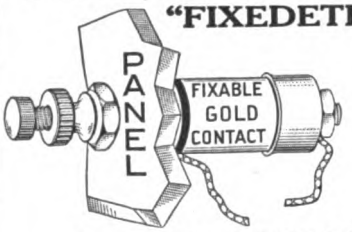
THE STERLING MFG. COMPANY
2843 Prospect Avenue Cleveland, Ohio

THE REFLEX

"VARIOTECTOR"

Fits Cup or Panel $1.50 Crystal "Refills" 50c

"FIXEDETECTOR"



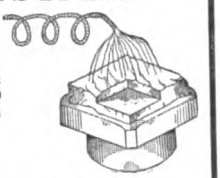
Like above, but permanently adjusted

$1.25

GIANT CRYSTALS

TRIPLE SIZE—TRIPLE LIFE—
TRIPLE POWER—

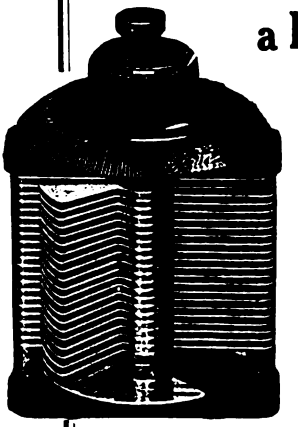
Single Pyrite or Galena, 75c
Twins, 90c; Triplets, $1.00
"Vario-tenser" Gold-Brush Contact, 50c
Guaranteed by Dealers Everywhere



FOOTE

Mineral Co.,
Mfrs. & Distrs.
102 N. 19th St. Phila.
Mineral Pioneers for Nearly 50 Years

Your Condenser Makes a Difference



Pick up those distant stations louder and clearer. Eliminate noise and interference. Get more pleasure out of your receiving with

Elgin
Precision Condensers

Fully Guaranteed

Size	Capacity	Plain	Vernier
3 Plate	.000063 M. F.	$1.75	
11 Plate	.00025 M. F.	2.40	$4.00
17 Plate	.00035 M. F.	2.75	
23 Plate	.0005 M. F.	3.00	4.50
43 Plate	.001 M. F.	4.00	5.50

3" diameter composition dials, 50c extra

See your local dealer. If he cannot supply you send his name with your order to

Elgin Radio Corporation

Radio Division of The Elgin Tool Works, Inc.
69 No. State St. Elgin, Illinois

Take This Loop on Trial

Ten days to test out this remarkable loop right in your own home.

The only loop aerial of its kind. Flat as an atlas, extremely compact and all enclosed in polished Bakelite, with binding posts for various wave meter lengths.

Select the type for your set, and send C. O. D. order now.

Your money promptly refunded if you decide to return it.

Type A-737 (300-700 meters) 6 inches square—non-directional.....**$10**
Type A-7238 (175-1000 meters) 6 inches square—non-directional.....**$12**
Type B-2837 (300-700 meters) 18 inches square—directional.....**$20**
Type BL-2820 (200-18,000 meters) with honeycomb coil mounting. 18 inches square—directional.....**$25**

Send for Bulletin I-102

V-DE-CO RADIO MFG. CO., Dept. F, Asbury Park, N. J.

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Dance to the world's finest music!

Hear the wonderful orchestras of all the big cities, as clearly as if they were in your home. Merely by the addition of "Push-Pull" power amplification to your present audio frequency amplifier—*using any good loud speaker and All-American Power Amplifying Transformers*—you can "bring in" distant stations with amazing volume (wholly undistorted) and a roundness, richness, depth and purity of tone positively delightful! Your dealer will gladly explain.

Standard on the better sets

ALL-AMERICAN

AMPLIFYING TRANSFORMERS

Largest Selling Transformers in the World

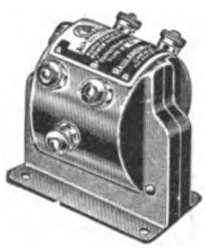
Because they bring in voices and music as loudly and distinctly as you wish—without annoying distortion—All-American Amplifying Transformers enjoy the widest use and are the best-liked of all transformers.

"Old-timers," leading dealers, makers of the better sets, radio engineers—all these critics regard All-American as peerless.

Enormous production makes it possible to price them low, in the face of their superiority. There is nothing gained by paying more. At all the stores.

SPECIAL OFFER!

We will send the All-American diagram-circular on Power Amplification—also Book of 22 Tested Hook-ups—on receipt of 4c in stamps.



RAULAND MFG. CO., 2650 Coyne St., Chicago

(Pioneers in the Industry)

SUITABLE FOR ALL SETS AND CIRCUITS

All-American Audio Frequency Transformers. 3:1, **$4.50**; 5:1, 10:1, **$4.75.**

All-American Radio Frequency Transformers. For wave lengths 150 to 550 meters. **$4.50.**

All-American Power Amplifying Transformers. Input and Output types. Each **$6.**

Watch for the new All-American Long Wave Radio Frequency Transformers suitable for Super-Heterodyne Circuits

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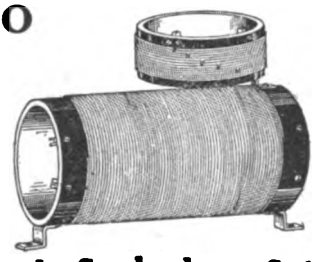
$5.50



The Only Authorized Cockaday Coil

Capacity effects, high dielectric losses, leakage, broad tuning and howling caused by coils made of cardboard tubes, shellac, and cotton covered wire must be eliminated to get efficient results from Cockaday sets and other circuits.

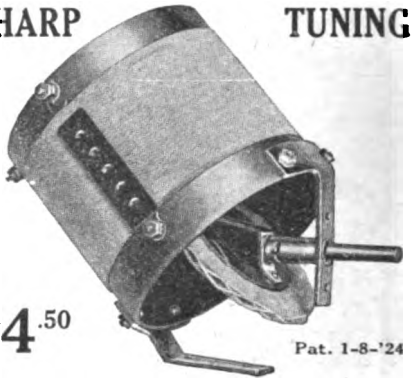
Replace your old coils with the only Authorized Cockaday Coil, built exactly in accordance with latest specifications of Laurence M. Cockaday, inventor of the famous Cockaday Four Circuit Tuner.

Built on ⅛" hard rubber tubes, threaded —no shellac, and wound with double silk covered wire. Gives maximum selectivity, greater volume, sharp tuning, maximum sensitivity and tonal quality when properly hooked up. Guaranteed.

At your dealers, otherwise shipped to you postpaid.

PRECISION COIL CO., Inc.
209-B Centre Street New York

SHARP TUNING



$4.50

Pat. 1-8-'24

The New Hartman Variocoupler *with* Spider Web Wound Rotor

Its small size saves panel space. Clearer reception and maximum efficiency insured. Dead shaft has no capacity effect in tuning. Pig Tail contacts; no live brackets. If your dealer can't supply you, write us.

The Hartman Electrical Mfg. Co.
33 East 5th Street, Mansfield, Ohio

Radio HARTMAN Products

Acoustically Correct

The Trimm extra large Loud Speaker unit with its wonderful ADJUSTO instantly regulating loud speaker to signal strength insures greatest volume without flaws or distortion. At three prices:

TRIMM STANDARD MODEL

With non-metallic horn 21½" high; bell 10" diam..... **$22.50**

TRIMM GRAND

With solid Cast Aluminum Horn; the world's finest loud speaker..... **$35.00**

TRIMM

Phonograph Attachment **$10.00**

TRIMM High Grade HEADSETS

"Professional" model-3000 ohm. . **$7.65**

"Dependable" model-2400 ohms. . **$5.00**

Any Trimm product shipped and sold on approval and Guaranteed FOR LIFE. Write for descriptive folders. Mention your dealer's name.

TRIMM RADIO MFG. CO.
Dept. 51
59 S. Clinton St. Chicago, Ill.

HEATH'S
Radiant Condensers

A condenser short-circuited will create no end of trouble. Better to think of the plates **first,** and buy a Heath **Radiant Condenser,** with the PERMANENTLY F-L-A-T Plates. Compressed and hardened like the plates of a dreadnaught. **Guaranteed Non-warping.**

Micrometer Vernier

LIST PRICES
Vernier Type
All including 2⅛" dial and knob.

13 Plate, $5.00; 25 Plate, $5.50; 45 Plate, $6.50

PLAIN TYPE

	Mfd. Cap.	
11 Plate approx.	0.00025	$2.30
17 " "	0.00035	2.55
23 " "	0.0005	2.90
43 " "	0.001	3.30

Genuine Condensite Dials 65c Extra

Jobbers and Dealers: Write Immediately for Proposition.

HEATH RADIO & ELEC. MFG. CO.
204 First Street Newark, N. J.

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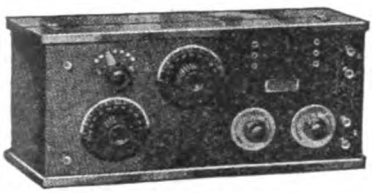
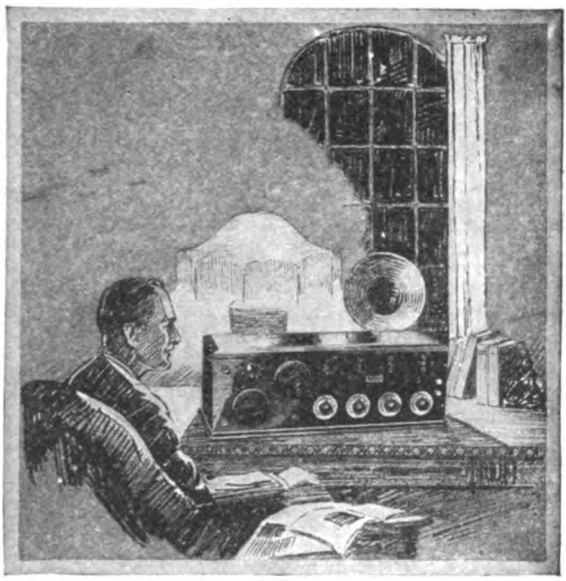


E·D·Elliott of Milford, N.Y. establishes a record

Think of getting London, England, Fairbanks, Alaska, and La Palma, Panama, when you live in New York! Yet this is the experience of Mr. Elliott, one of the hundreds of enthusiastic users of MIRACO sets. With the inexpensive outfit shown here, priced at **only $29.50,** he received the following list of stations—*results that would do credit to a set costing three or four times as much.*

	London, England	WHAY	Wilmington
WLAY	Fairbanks, Alaska	WRAY	Scranton, Pa.
5NW	La Palma, Panama	WOAY	Birmingham
PWY	Havana, Cuba	WSB	Atlanta, Ga.
CFAC	Calgary, Can.	WMU	Washington
CJCY	Calgary, Can.	WCAT	Rapid City
KFBC	San Diego, Cal.	WRC	Washington
KSL	San Francisco, Cal.	KYW	Chicago
KHQ	Seattle, Wash.	KFCB	Phoenix
WJAR	Providence, R. I.	WWT	Buffalo, N. Y.
KFBU	Lorine, Wyo.	WHAS	Louisville, Ky.
WEV	Houston, Tex.	WCAY	Milwaukee, Wis.
WMAT	Duluth, Minn.	WLW	Cincinnati, O.
WPM	Washington	WDAW	Omaha, Neb.
WRAA	Houston, Tex.	WOQ	Kansas City
WHB	Kansas, Neb.	WPAW	Wilmington
KFHB	Hood River, Ore.	WCE	Minneapolis
CFCA	Toronto, Can.	WCX	Detroit. Mich.
CKCE	Toronto, Can.	WLAZ	Warren, O.
CJCI	St. John, Can.	WAAS	Decatur, Ga.
WRP	Dallas, Tex.	WTAM	Cleveland, O.
NGE	Miami, Fla.	WWJ	Detroit, Mich.
KGA	Oakland, Cal.	WJAZ	Chicago, Ill.
KFEL	Denver, Colo.	WDAP	Chicago, Ill.
WIAZ	Miami, Fla.	WGY	Schenectady, N. Y.
WKY	Oklahoma City	WJZ	New York City
WDAE	Tampa, Fla.	WEAF	New York City
WEB	St. Louis	WOR	Newark, N. J.
WRK	Hamilton	WHAS	Louisville, Ky.
WHAB	Galveston, Tex.	WEAB	Dodge, La.
6ZV	Salt Lake City	WKD	Gainville, Ga.
NAA	Arlington Va.	WUQ	Washington, D. C.
WJAX	Cleveland, O.	KMO	Tacoma, Wash.
WBZ	Springfield	KOB	New Mexico
WOO	Philadelphia, Pa.	WDAR	Philadelphia, Pa.
WOS	Jefferson City, Mo.	WFI	Philadelphia, Pa.
WOK	Pine Bluff, Ark.	WIP	Philadelphia, Pa.
WLAG	Minneapolis	KDKA	Pittsburg, Pa.
WFAZ	Charleston	WCAE	Pittsburg, Pa.
WJAB	Lincoln, Neb.	KMN	Butte, Mont.
WCT	Chicago	KQP	Hood River, Ore.
WMC	Memphis	WHAZ	Troy, N. Y.
WBAK	Harrisburg	WGR	Buffalo, N. Y.
WLAK	Bellow Falls, Vt.	WMAV	Auburn, Ala.
WBAN	Paterson, N. J.	KFDD	Boise, Ida.
WOC	Davenport	WNAL	Omaha, Neb.
WPAP	Winchester, Ky.	WCAP	Washington, D. C.
WMAM	Beaumont, Tex.	WQAB	Springfield, Mo.
WWZ	New York	WFB	St. Louis, Mo.
WBAY	New York	WDR	Detroit, Mich.
WGL	Philadelphia, Pa.	WNAC	Boston, Mass.
WMAF	Dartmouth, Mass.	WBAZ	Columbus, O.
WBAG	Bridgeport	CFZC	Montreal, Que.
WCAP	Decatur	WMAK	Lockport, N. Y.
WHN	Ridgewood	WGF	Des Moines, Ia.
WIAR	Paducah	WHAM	Rochester, N. Y.
WRP	Camden, N. Y.	WCAM	Villa Nova, Pa.
WGAR	Fort Smith, Ark.	WGAY	Madison, Wis.
WDAK	Hartford, Mass.	WWI	Dearborn, Mich
WCAG	New Orleans	WGAM	Orangeburg, S. C.
	WWAJ	Columbus, O.	



Radio's finest low-priced receivers

Here, in the improved MIRACOS, you'll find the same thrill of getting long distances, generally obtainable with only the most expensive and elaborate sets. To the whole family it will furnish entertainment, **unfailingly,** the whole year round—and at an initial price most every family can afford.

It isn't necessary, either, to be an expert at tuning in with the MIRACO. The operation is extremely simple. Scores of users everywhere tell us of the long-distance records they're making—Cincinnati hears 'Frisco, Denver hears Schenectady, New York hears Havana!

Such range as this is made possible through MIRACO'S many new refinements. Improved rheostats with multiple resistance windings enable you to use any type of tube, and a new aluminum shield prevents annoying body capacity effects. Shock absorbing pads prevent tube noises. Fully GUARANTEED against defects in material or workmanship. Price for 4-tube outfit shown above only **$54.50.**

Other details of MIRACO receivers are explained more fully in our new bulletin. Write today for a copy.

THE MIDWEST RADIO COMPANY
812 Main Street, Cincinnati, Ohio

The Improved MIRACO

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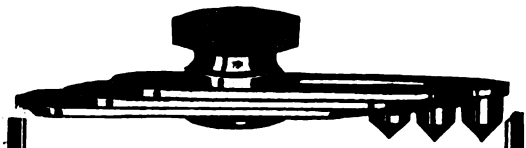


No More Grief Drilling Panels

No more spoilage! No filing and fussing to correct drill holes that failed to fit.

The Church UNIVERSAL TEMPLATE

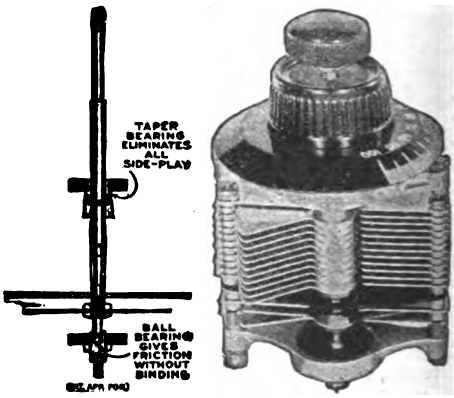
This precision instrument adapts itself to every conceivable angle, and makes it possible to transfer to your panel or baseboard the exact position of the correct drill holes for mounting any size radio instrument.

Sent postpaid $1.25

Jobbers and Dealers correspondence insited

RADIO INSTRUMENTS CO.
17 N. WABASH AVE. CHICAGO - U. S. A.

For Sturdiness and Accuracy Use Lombardi Condensers



Made in the most popular sizes, with aluminum plates, aluminum end brackets, with a ¼" diameter insulating bushing therein. (A perfect insulator, high in dielectric strength.)

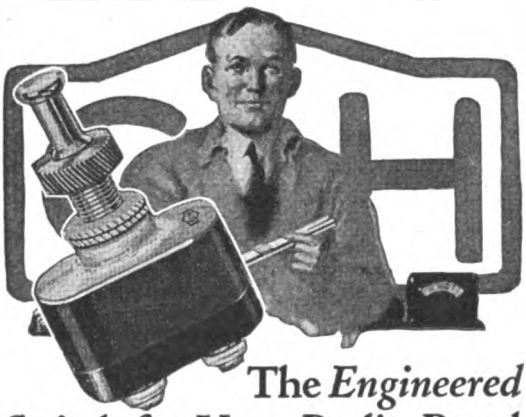
The tension as well as adjusting is accomplished by tightening and thrust plug, which has a spring plunger, causing a thrust of proper tension between a hardened steel ball and a 45 degree tapered brass bushing, this insures smooth running and a contact equal to a soldered joint; also a take up for wear in years to come.

Also makers of coils and sockets

Literature and prices furnished upon request

Lombardi Radio Mfg. Co.

67 MINERVA ST. DERBY, CONN.



The *Engineered* Switch for Your Radio Panel

Within the dustproof fibre case of the radio switch by Cutler-Hammer, master builders of all control apparatus, is a mechanism that you can safely insert in your most delicate circuit without introducing microphonic noises. Its floating contactor is independent of the button—touching it or jarring the table will not produce noise in your phones. Sold by radio dealers everywhere. Insist on the genuine in the orange and blue box—the C-H trademark is your assurance of satisfaction.

THE CUTLER-HAMMER MFG. CO.
Member Radio Section, Associated Mfrs. of Electrical Supplies
MILWAUKEE, WISCONSIN

RADIO SWITCH

Better Tone for Your Radio!

FRANK D. PEARNE, famous Radio engineer, says TRANSCONTINENTAL RIBBON Aerials aid reception by combining maximum surface with minimum resistance. FORREST, eminent inventor, says, "I get best results by twisting Ribbon Aerial, 2 twists per 50 feet." Complete with snap hooks soldered to ends for instant attachment to insulators.

Transcontinental RIBBON COPPER AERIAL — Ribbon — **50-Foot $1.50**

75-Ft. $2.25
100-Ft. $3.00
150-Ft. $4.50

Clearer tone, greater volume, increased distance and selectivity guaranteed or **your money refunded!** Improves any set, tube or crystal. A laboratory product, with capacity, resistance and strength calculated to give better results.

Try It Without Risk! If your dealers cannot supply you, order direct from manufacturer, enclosing price. 100-foot length most generally used. Money-back guarantee protects you.

Acorn Radio Mfg. Co. 1806 S. Racine Ave. Dept. 208 CHICAGO

TRANSCONTINENTAL RIBBON AERIAL

DEALERS! Write for Special Offer!

Please refer to POPULAR RADIO *when answering advertisements.*

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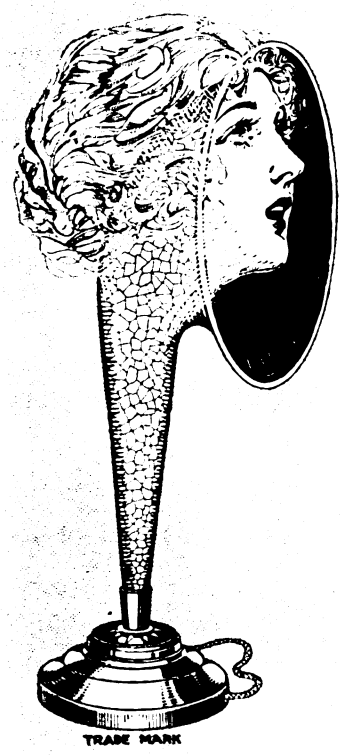
Atlas
TRADE MARK



RADIO-REPRODUCTION LOUD SPEAKER

THE Atlas Radio RE-PRODUCTION of the artist's performance brings the studio into your home.

Complete **$25**

WRITE FOR BOOKLET "B"

Atlas Loud Speaker Unit
With Phonograph Coupling **$13.50**
Without Phonograph Coupling **$12.50**

Sole Canadian Distributors
Marconi Wireless Telegraph Co. of Canada, Ltd.
Montreal, Canada

Multiple Electric Products Co. Inc.

Makers of MONO—TIME-LAG FUSES—MULTIPLE
2 ORANGE STREET **NEWARK, N. J.**
DISTRICT OFFICES AT
NEW YORK, CHICAGO, BALTIMORE, PHILADELPHIA, BOSTON, PITTSBURG, DETROIT, SAN FRANCISCO, KANSAS CITY, ST. LOUIS, LOUISVILLE, DENVER

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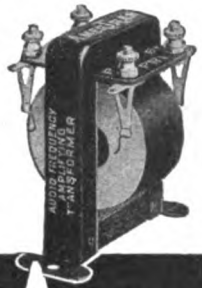


STANDARD
OF
EXCELLENCE

for audio amplification

With all tubes
In all stages

AMERTRAN

TRADE MARK REG.U.S.PAT.OFF.

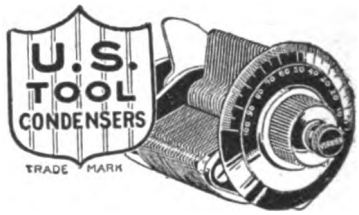
Improve your set with an AmerTran

Its flat-top, distortionless amplification curves assures a pure tone rendering of the full musical scale.

Type AF-6: Turn ratio 5:1. Price $7. Ask your Electrical Dealer or sent carriage charges collect.

Send for Circular 1005

American Transformer Company
Designers and builders of radio transformers for over 22 years
175 Emmet Street, Newark, N. J.



for the

4-Tube Superdyne

A precision condenser of national reputation
100% GUARANTEED

U. S. Tool Type CS 114—23 Plate; Capacity .00055 Mfd. or Type CV 123—24 Plate, Vernier Cap. .00057 Mfd.

Insulated and shielded by end plates of

CELORON—*Low Dielectric Losses*

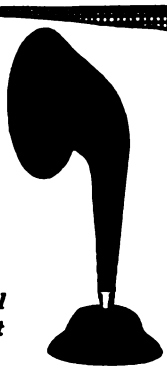
Condensers of recommended plates and capacities for all known circuits are stocked by leading radio retailers.

Write for Literature

U. S. TOOL CO., Inc.

116 Mechanic St., Newark, N. J.

$8



A phone plus a FIBERTONE makes a beautiful musical instrument

The highest tonal quality undisturbed by either metallic noises or distortion is best obtainable with a fiber horn. This one factor is the reason for Fibertone's popularity. And the low price for such fineness is a sensation of the radio world. The beautiful crystalline finish of the Fibertone fits it for any place where the finer things of the home are seen.

If your dealer cannot supply you write direct.

FIBER PRODUCTS COMPANY
34 Orange St. Bloomfield, N. J.

FIBERTONE

RADIO HORN

World's Greatest BATTERY BARGAIN

FREE Hydrometer and "B" Battery

Written 2 Year Guarantee
Your Proof of Satisfaction

SAVE 50%

Thousands of POPULAR RADIO Readers will profit by this amazing offer. They will buy the famous 2-year guaranteed World battery at the lowest price ever quoted—They will get a hydrometer and a "B" Battery FREE. And they get the best battery built. It is "World" quality that makes possible our 2-year ironclad guarantee. It is "World" quality that makes "World" owners "tell their friends"—that's the best proof of performance our product can have.

Compare These Prices:

Special 200 Hour Rechargeable Storage Batteries		**6 Volt 60 Amp.**	**$8.**
2 Volt for W.D. 11 and 12 tubes	**$5.00**	**6 Volt 80 Amp.**	**10.**
		6 Volt 100 Amp.	**12.**
		6 Volt 120 Amp.	**14.**
4 Volt for U.V. 199 tubes	**8.00**	**6 Volt 140 Amp.**	**16.**

Send No Money

You need not send a penny. Just clip this ad and attach your name and address. The battery will be shipped to you the day your order is received. When the battery arrives, inspect it—read our 2-year guarantee before you pay one penny. Convince yourself you are protected from every angle—that the World battery price saves you $. Get the "B" Battery and hydrometer FREE. Order today.

Special Offer

Clip and mail this ad with your World battery order and get this hydrometer and "B" battery free. Or, if you disc. for cash in full with order.

WORLD BATTERY CO.
Dept. 3, 1219 So. Wabash Ave., Chicago

World

Please refer to POPULAR RADIO *when answering advertisements.*

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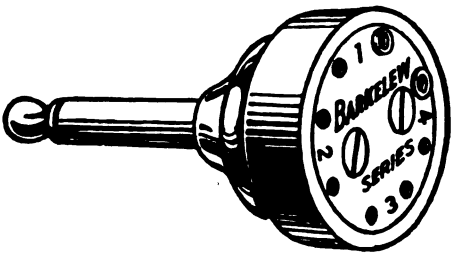
Barkelew Four-Phone Plug

PATENTS PENDING

Connects four phones or less in series to any Radio Set employing standard telephone jacks



Cat. No. 616
Price $1.50

It adds to the appearance of any set. With all phone tips adjusted, the diameter is but 1¼ inches

CHICAGO, ILL.
[illegible] Clinton St.

BARKELEW

SAN FRANCISCO.
75 Fremont St.

ELECTRIC MANUFACTURING CO.
MIDDLETOWN, —— OHIO.

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Distance & Volume

are found in

RayCoils

RayCoils "A" for Reinartz, Ray Coils "B" for RCS and Ultra Audion Circuits, RayCoils "C" for RCS, Ultra Audion and Tuned Radio Frequency for All Circuits. RayCoils "D" for Neutralizing Circuits 4 & 5 Tubes.

A = $2.50
B = 2.00
C = 2.00
D = 2.00

Use the RCS Circuit with or without Radio Frequency for Simplicity in operation and results. Not equalled by any set for volume and distance.

Coast to Coast stations on loud speaker

Coils in Separate Box
With Wiring Diagram

Working **Blue Prints** of four sheets 12 x 18 of all standard circuits, such as The Variometer, Reinartz, RCS one and three tube sets and five tube Neutralizing Circuit 50 cents a set.

We also carry a complete line of Carter, Howard, Kellogg, All American and Trimm parts.

If your dealer cannot supply you, we will mail direct.

R. C. SCHOONHOVEN
Major Q. M. R. C.
ELGIN, ILL.

Montreal-California

(More than 2500 Miles)

on one Myers Tube

(½ size)

Mr. W. E. Gerrard, 73 Pine Avenue, St. Lambert, Montreal, Canada, using only one MYERS TUBE, hears KDZB, Bakersfield, California.

Get distance with clarity. MYERS are the only tubes correctly designed for radio without bunched leads. Two types—for dry or storage battery. Insist on MYERS at your dealers—otherwise send purchase price and be supplied postpaid. Write for free circuit diagrams.

$5 EACH complete with mounting clips ready to mount on your set; no sockets or extra equipment necessary.

E. B. Myers Co. Ltd.
Radio Vacuum Tubes
240 Craig St. W. Montreal, Canada

"All the difference in the world--"

That's what a well-known scientist engaged in research work for one of America's great universities said after comparing our rheostat with many others. The

UNITY

Vernier Rheostat

gave him the most satisfactory results of any rheostat used. It will give you the same satisfaction. We guarantee it. The exclusive construction of the UNITY permits the most infinitesimal variation in resistance. You'll appreciate the cut-out switch feature.

PRICE
$2.00

For most tubes you need a 6 Ohm Rheostat

25 OHMS
for 201-A and 301-A

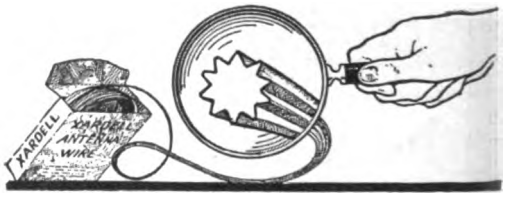
40 OHMS
for 199 and 299 Tubes

Don't be satisfied with a substitute

Ask your dealer for UNITY rheostats

UNITY MANUFACTURING CO.
224 N. Halsted St., Chicago

DX-10-POINT



ANTENNA WIRE

$2.00

PER HUNDRED FEET

Designed for long distance reception and is different and better than the usual make-shifts, being hard drawn from the finest copper, having a corrugated surface with ten collecting points on the circumference. This gives a greater collective surface to the high frequency radio currents. The result is extreme sensitiveness and increase in range and clearness of any set from the simplest Crystal to the finest multiple tube receiver.

Use this antenna wire and enjoy the full possibilities of your set.

Sold in coils 100 feet, 200 feet and 500 feet. Order direct or from your nearest dealer.

Dept. R

Xardell Corp.
UTICA, NEW YORK

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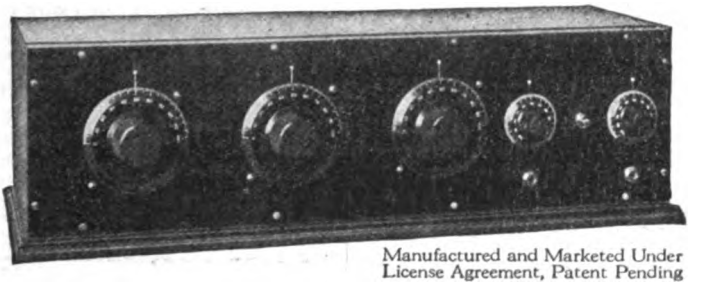
Pathé

"MINUTE MAN"
Radio Receiving Set

incorporating

Pathé Type "P" Phusiformers



Manufactured and Marketed Under License Agreement, Patent Pending

Price $125.00
(tubes, batteries extra)

A 5-tube de luxe set combining all the desirable features of the best receiving sets:

Does not oscillate.
Does not re-radiate
Highly selective.
Sensitive to distant stations.
Free from hand capacity.
Simple to operate.

The Pathé "Minute Man" is housed in a genuine mahogany cabinet equipped with beautiful mahogany panel and gold engraved dials, making a handsome as well as efficient instrument.

FREE

A most complete and detailed instruction book showing how to construct a "Minute Man" Receiving Set will be sent you absolutely free of charge. Address Dept. 194.

Jobbers and Dealers

Write Dept. 194 for catalogs and prices of Pathé line.

PATHÉ PHONOGRAPH & RADIO CORP.
20 GRAND AVENUE :: BROOKLYN, N. Y.

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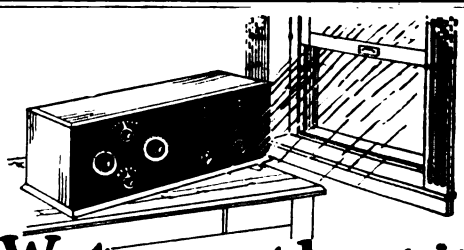
Is Your Set a Piece of Furniture?

Your radio set deserves a place in the best room of your house. It is impossible to give it this place if it is necessary to have unsightly wires running from part to part and ugly batteries, chargers, and speaker-horns, etc., in close proximity to it.
There is a place for each part of the set. There are grooves for various sizes of panels. The horn is built in and there is a convenient place to fasten the speaker unit. A spacious cabinet in the lower part will conceal the charger and all batteries.

PRICES $35.00 and up

Whaling Wood Products Co.
Dealers Write 3101 Orange Ave. CLEVELAND **Dealers Write**



Water wont hurt it!

Bakelite-Dilecto Panels will not warp, split, swell, check, crack, shrink or change their color or brilliant lustre under the severest weather conditions. Water does not hurt them. Neither do steam, oil, solvents, heat and cold.

bakelite-dilecto

(A Laminated Phenolic Condensation Material)

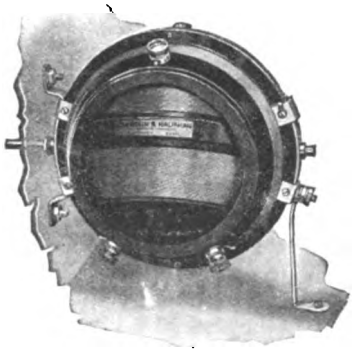
Foremost radio experts have found that Bakelite-Dilecto has every radio-advantage. The U. S. Navy and Signal Corps have used it for over *ten years*. Finished a beautiful, sleek black. Astonishingly tough, yet machines readily. Have your dealer get genuine Bakelite-Dilecto panels cut and drilled for you.

THE CONTINENTAL FIBRE CO.
Factory: Newark, Delaware

Service on Bakelite-Dilecto (also Continental-Bakelite, Conite, Contex and Vulcanized Fibre) from:

NEW YORK, Woolworth Bldg. CHICAGO, Wrigley Bldg.
PITTSBURGH, 301 Fifth Ave. SAN FRANCISCO, 75 Fremont St.
LOS ANGELES, 307 S. Hill St. SEATTLE, 1041 Sixth Ave., So.

Offices and Agents Throughout the World



Variotransformer

A variable radio frequency transformer

Only one of eight standard HARD RUBBER moulded tuners.

Send for Literature and Diagrams

THE HOME OF MOULDED TUNER SPECIALTIES

LANGBEIN & KAUFMAN
654 Grand Ave. **New Haven, Conn.**

AMPL-TONE PHONES

A THREE DOLLAR
LOUD SPEAKER UNIT FOR HOME MADE SPEAKER
FREE
With Pair of Phones
Money Back Guarantee
Dealers Wanted

C. M. FRENCH MFG. CO.
SEYMOUR, CONN.

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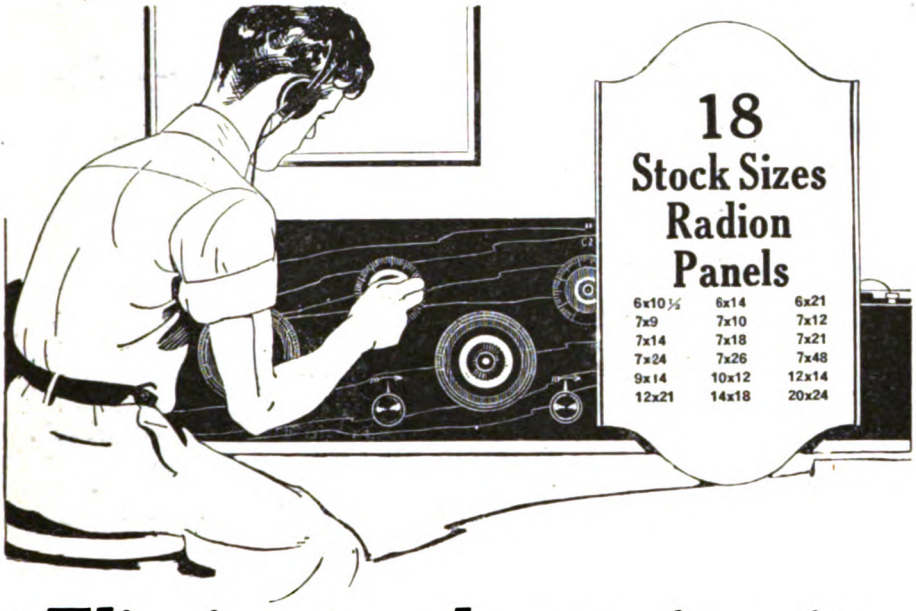
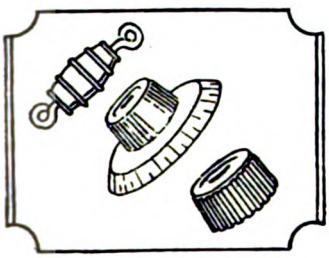


Eliminate short circuits and distortion



Any panel material which will absorb moisture is apt to cause short circuits and distortion. Radion Panels are impervious to moisture. They eliminate most of the leaks of radio frequency currents where other materials fail.

Your dealer carries a stock of Mahoganite or black Radion Panels, Dials and Knobs. Experienced amateurs and professionals, too, demand genuine RADION. Try it and you will notice the difference.

Look for this stamp on every genuine RADION Panel. Beware of substitutes and imitations.

RADION

The Supreme Insulation

PANELS

AMERICAN HARD RUBBER CO., 11 Mercer St., N. Y.

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Free Parts for Your Radio Sets!

Your choice of these valuable premiums, free to you as a reward for securing only a few subscriptions to POPULAR RADIO

A FEW moments of your spare time spent in bringing POPULAR RADIO to the attention of your friends and acquaintances will yield you big rewards. Never before have we been able to offer such attractive and liberal premium values as these.

Glance over this broad list of radio parts and equipment that you can secure FREE, merely by introducing POPULAR RADIO to some of your friends and acquaintances who will appreciate the opportunity of subscribing to this most interesting and helpful magazine.

Show this copy of POPULAR RADIO to other radio fans. The pages of the magazine will speak for itself. Then send us the names of your friends, with $3 for each yearly subscription, and take your choice of any of the following premiums. They'll come to you *absolutely free.*

Any One of These for 2 Subscriptions:

Dubilier Ducon, and choice of any *three* Dubilier Micadon Grid Condensers of the following capacities: .00025; .0005; .001 or .002.

Pudlin Tubular Grid Leak (2 megs.); Dubilier Micadon Grid Condenser .00025; Cutler Hammer 6 ohm Rheostat, and *one* Alden Napier Socket, choice of either 201A or WD-11.

Three Pacent Jacks (*one* single circuit and *two* double circuit).

Bakelite Panel, size 7 x 18 inches.

22½ volt B Battery, large, choice of Burgess or Eveready.

One copy of Ballantine's "Radio Telephony."

Cutler Hammer 30 ohm Rheostat and choice of *one* Alden Napier Socket: 201A, 199 or WD-11.

Your Choice for Only 3 Subscriptions:

Bakelite Panel, size 7 x 24 inches.

Set of Mounted De Forest Coils; 35, 50, 75.

Amsco Compensating Condenser and choice of any *one* Alden Napier Socket: 201A, 199 or WD-11.

Two Cutler Hammer 6 ohm Rheostats and *one* Cutler Hammer Potentiometer.

Diode Dry Cell Tube and Cutler Hammer 6 ohm Rheostat.

"Scientific" Headset.

Big Value for 4 Subscriptions Each:

Lefax Loose Leaf Radio Handbook with full year's free supplement service.

Sleeper Variocoupler with switch lever and points.

Cardwell 21 Plate Condenser or General Radio 23 Plate Condenser.

Cardwell or Se-Ar-De 17 Plate Condenser.

Cardwell 11 Plate Condenser and Pacent Jack.

U. V. 200 or C. 200 Vacuum Tube.

"Ampl Tone" Phones.

Free With 5 Subscriptions Each:

Cardwell 43 Plate Condenser.
Spiderweb Coil and Mounting.
Brandes or Holtzer. Cabot No. 4 National Phones.
Amertran Transformer.
Atwater Kent or Sleeper Variometer.

U. V. 201A or C. 201A Vacuum Tube.
U. V. 199 or C. 199 Vacuum Tube.
WD-12 or C. 12 Vacuum Tube.
WD-11 or C. 11 Vacuum Tube.

ALL premiums will be sent prepaid, immediately on receipt of your orders. If you want some particular part that is not listed here, write us and we'll tell you how many subscriptions you'll need to get it *free.* Or if you prefer *cash commissions,* just drop us a postcard asking for full particulars.

Renewals of old subscriptions or extensions of present subscriptions count the same for you as new subscriptions. In other words, any subscription you receive entitles you to your reward in cash or in premiums. Simply send us $3 to cover each subscription you take and we will send you your premiums.

Start today, and you'll have your required number of subscriptions in a jiffy!

POPULAR RADIO

Dept. 41 9 East 40th Street New York City

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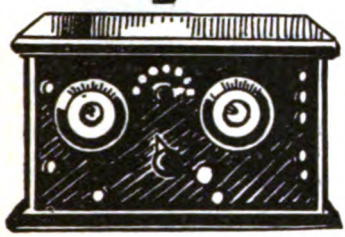
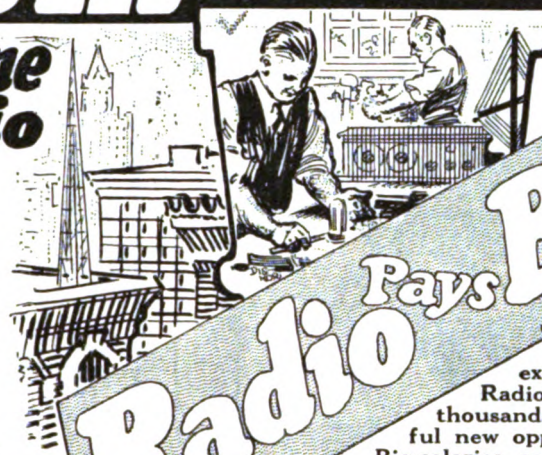
"Tune in" on Success

Learn at Home To be a Radio Expert





Radio Pays Big

The amazing expansion of Radio has opened thousands of wonderful new opportunities. Big salaries, easy and fascinating work, short hours and an excellent future are offered to ambitious men who enter the Radio field now.

Free 1000 Mile Radio Outfit

This set, when erected, has a range of over 1,000 miles. The cabinet is elegantly finished in a beautiful, lustrous mahogany. You can sell it at a handsome profit if you care to, after you have completed my course. Remember, you do not pay a single penny for it.

Membership Is Valuable!

Upon completion of my course, you receive a membership in the Radio Association of America. This designates that you are a thoroughly trained Radio man. It gives you prestige and a standing in your community not otherwise possible.

Thousands of Big Pay Opportunities

My course enables you to construct, install, operate, repair and sell Radio equipment. As my representative, you can, using either your full time or spare time, take orders from your friends and neighbors. You can easily earn from $35.00 to $125.00 a week installing Radio sets in your locality. It is being done every day by my students. What others have done, you can do.

On this very day there is someone in your neighborhood who is buying a Radio Set from someone else and is having Radio work done by others. On this very day there are big pay Radio positions that are going begging. This will be repeated tomorrow and for a long time to come. Time is precious. Begin at once to get the training that will fit you to cash in on this great chance. At least investigate. Mail the coupon to get the interesting bulletin "Radio Facts."

PROOF

Dear Mr. Mohaupt:
Your lessons are very easily digestible. To say that I enjoy them would be putting it very mildly—indeed, I crave them.
And, about the job at the Operadio Corporation; yes, I got it, thanks to you. I am learning to be an inspector at present, but I'll not stop there.
Please send me additional lessons as soon as possible.
GEO. A. GRAESSLE.

Radio Experts Earn $3,000 to $10,000 a Year

New Radio Stations are being erected every day. Thousands of corporations are putting in private stations. Every large vessel requires its Radio Staff. From everywhere comes the urgent call for Radio Trained Men. There is almost no limit to the pay. Will you step forward and grasp this brilliant money-making chance or are you going to let days drift by and let others take in the cash?

"Learn by Doing" Method

My course is not "high-brow." It is written in plain, everyday language that can be understood by any man. You need have no previous training or experience. I give you a receiving set so that I can take you thru the various steps of Radio work in a practical way. You will be delightfully astonished in having made clear to you the wonderful forces of Radio that appear so mysterious to the untrained person.

FREE I have ready for you a copy of "Radio Facts" which tells you of the latest opportunities that exist in the great field of Radio. I want you to note my "Money Back" guarantee that protects you absolutely. I also want to tell you about the big free 1,000 mile Radio Tube Set that I give away free with my course. I urge you to act at once. Fill in your name and address on the coupon and mail it to me immediately.

A. G. Mohaupt, Radio Engineer
RADIO ASSOCIATION OF AMERICA
Dept. 55 Chicago, Ill.

MAIL COUPON

A. G. Mohaupt, Radio Engr., Radio Assn. of America,
Dept. 55, Chicago, Ill.

Please send me details of your Home Study Course—also your Free "Radio Facts" and information on how I can get a FREE 1,000 mile Radio Set.

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CITY ..... STATE .....

A.G. Mohaupt Radio Engineer
Radio Association of America
Dept 55 Chicago, Ill.

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THE NEW
METALECTRIC SOLDERING IRON

Operates with the Simplicity—
Ease and Efficiency of a
Pencil on any Electric Current

ACCEPTED
As the logical Solution
to Radio Soldering
Problems

Ample Heating Capacity
Handle Always Cool

Now
$3.75
"Worth it"

"An All-metal
Quality Instrument
with a worthwhile Guarantee"
of Your Dealer or Write
Post Elec. Co., Mfrs. (Inst Div.) 30 E. 42 St., N. Y. C.

The
"EZTOON"
(Easy Tune)
Radio Dial

is two dials in one with a 40 to 1 ratio.

"EZTOON" dials make possible vernier adjustment of vario-coupler, variometer rheostat, potentiometer, or tickler, as well as saving the expense of a second set of adjustable plates on condensers.

The "EZTOON" gives unusual close tuning so essential in Heterodyne, Acmedyne, Neutrodyne and tuned radio frequency circuits.

No panel holes to drill. Just take off old dial, slip on "EZTOON" dial and tighten set screw.

Sold under positive money-back guarantee.

Ask your dealer. If he cannot supply you, we ship parcel post 3" dial, $2.00; 4" dial, $2.25. Jobbers — Dealers — Manufacturers: Write for discounts.

With
"EZTOON"
(Easy Tune)
RADIO DIAL
You Can
bring in stations that heretofore you have passed up as impossible.
Get and hold stations.
Use it on any and all types of receiving sets to obtain vernier adjustment unobtainable before.
Tune in DX stations you never heard before.
Obtain vernier adjustment of all tuning instruments within your set.

BUTLER MANUFACTURING CO.
3236 W. Washington St., Indianapolis, Ind.

"You get every tone with a Pacent Phone"

"EVERYTONE"
guaranteed
RADIO HEADSET

The "EVERYTONE" is low in price. But it is extremely high in all the qualities you expect to enjoy in the headset you buy — clear reception, without distortion—comfort and long life.

Everytone Headset,
3000 Ohms—$3.75
At all good Radio Dealers
Write for bulletin P-4

PACENT ELECTRIC CO. Inc.
22 Park Place New York

Pacent
RADIO ESSENTIALS

FOUR CIRCUIT COIL SET

$2.50

"A" Coil covered square wire.

"D" Coil bank wound.

Full set A, B, C and D coils made exactly according to Cockaday's specifications. Full size blue prints and illustrated instructions with each set.
Materials for standard Four Circuit Tuner—panels, coils, condensers, verniers, grid leak, vernier rheostat, socket, jack, dials, switch, contacts, posts, busbar wire, spaghetti, etc. (no tubes or phones).

Complete for $11.65

IMPROVED TYPE COILS
Double silk covered wire on Bakelite tubing per set $4.00
Complete materials for 5 tube improved Cockaday set $58.75

All parts in stock. Get our price list.
Postage additional on all orders.
Send no money. Order by post card, pay the postman.

RADIO SURPLUS STORES
HELENA, MONTANA

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The "RICO" Grand Opera Loud Speaker Unit

You have no doubt read or heard that *every* loud-speaker is positively the best one ever manufactured. We could with very little effort make similar claims—on paper—and perhaps go other "ad" writers one better. Modesty, however, forbids. We therefore make the following statement:

Get a "RICO" GRAND OPERA LOUD-SPEAKER UNIT from your dealer or direct from us. Compare it with any loud-speaker you have now or you have ever heard. Consider the money you have paid is on deposit with your dealer or with us. If after 5 days you find the "RICO" GRAND OPERA LOUD-SPEAKER UNIT does not give you greater volume—does not give you greater clarity of sound—does not give you greater satisfaction than any other loud-speaker unit—then our dealers or we will gladly refund the purchase price.

$7.50

DESCRIPTION: This loud-speaker unit is ideal for phonographs. With it, you can turn your phonograph into a loud-speaker. Any good horn, however, can be attached to it. (Speaker does not work with crystal sets, only on vacuum tubes.)

No Metal Can Touch Diaphragm

Patented Dec. 25, '23

This feature is not found in any loud-speaker except the "RICO" GRAND OPERA LOUD-SPEAKER UNIT. Diaphragm cannot rattle. Metallic, harsh sounds are entirely eliminated

and

The "RICO" GRAND OPERA LOUD-SPEAKER UNIT is *fully adjustable.* For light or soft tones, simply turn the milled rim for best results. With this arrangement you can get either tremendous volume or soft tones, as you desire.

Aluminum shell and cap highly nickel-plated and polished. Five-foot green cord furnished. No. 75 "RICO" GRAND OPERA LOUD-SPEAKER UNIT as described. Price $7.50.

The "RICO" Straight Line Condenser

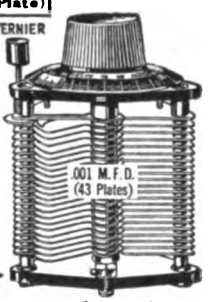
This condenser marks a revolution in condenser building. It is the simplest and most practical type yet developed for broadcast and amateur work. This condenser has been developed by our engineers after considerable research work and has been pronounced perfect by experts.

THREE STYLES
.001 mfd. (=43 Plate)
.0005 mfd. (=23 Plate)
.00025 mfd. (=11 Plate)

NEW TYPE

This Replaces This

Both Instruments Drawn to Scale



OLD TYPE

The "Rico" condenser weighs 6 oz.
The old style weighs 15 oz.
"Rico" vernier type has only one dial.
Old style requires difficult mechanism.

Manufactured in three types, to replace 43 plates, 23 plates and 11 plates.

No. 450 "Rico" Condenser .001 mfd. (=43 plate capacity)... $1.75

No. 423 "Rico" Condenser .0005 mfd. (=23 plate capacity)... $1.75

No. 411 "Rico" Condenser .00025 mfd. (=11 plate capacity)... $1.75

All above types without dial.... $1.50

Here are Some of the Outstanding Points:

1—Large capacity.
2.—Replaces all standard condensers.
3—Uses a minimum of space size, 3½" x 2½" x 1¾".
4—For panel mounting or for table mounting—universal in its scope.
5—Complete revolution of dial from minimum to maximum.
6—Vernier effect.
7—Absolute straight line curve.
8—Accumulates no dust between plates as is the case with air condensers.
9—Light weight. Condenser only weighs 3 oz.
10—Less than 1-10th amount of parts as used in old style mesh plate condenser.
11—Can never get out of order.
12—Impossible to short circuit.
13—Works in any position, vertical or horizontal. No counterweights needed.
14—Lowest in prices for high class condenser.

The "Rico" Straight Line Condenser must be seen to be appreciated. Made of the best materials money can buy. In a class by itself. All metal parts finished in nickel plate. We will refund your money if this condenser is not all we claim for it.

Dealers and Jobbers Write or Wire for Territory that is Still Open for Proposition

RADIO INDUSTRIES CORPORATION
131 Duane Street, New York City
Cable Address: Ricotrade, New York

SEND NO MONEY P.R.4
Radio Industries Corp.,
131 Duane St., New York City
Gentlemen:—Please send me by Parcel Post.....
.....
for which I will pay the postman the amount of.....
Name.....
Street.....
City..... State.....

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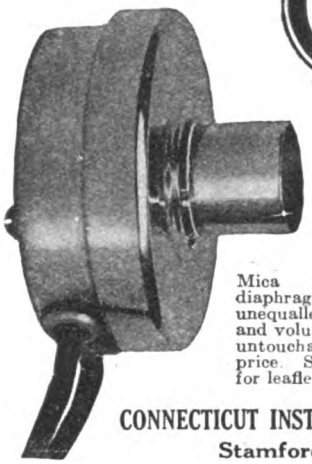
Listen to the Difference!

CIC



PHONOGRAPH ATTACHMENT

$6.50

Mica diaphragm—unequalled quality and volume—untouchable price. Send for leaflet.

CONNECTICUT INSTRUMENT COMPANY

Stamford, Conn.

Howard

BLUE SEAL GUARANTEED PRODUCT

Radio Co. Inc. Chicago, U.S.A.

HOWARD

No. 1001

6½ Ohm Rheostat..... $1.10

25 Ohm Rheostat..... 1.10

40 Ohm Rheostat..... 1.10

Patd. 870,042

HOWARD

No. 1003

200 Ohm Potentiometer .$1.50

400 Ohm Potentiometer .2.00

Patd. 870,042

Ask the man behind the counter to show you the Howard line of quality Radio Merchandise. Every piece is sold with the guarantee of satisfactory performance.

Jobbers write for discounts.

Send two cents for folder.

HOWARD

No. 1002

6¾ Ohm Micrometer Rheostat....$1.50

25 Ohm Micrometer Rheostat..... 1.50

40 Ohm Micrometer Rheostat..... 1.50

Patd. July 10, 1923

HOWARD

No. 1004

Multi Terminal Receiver Plug, instantaneous connection for as many as six pairs of standard receiver tips..... $2.00

Patd. Aug. 28, 1923

HOWARD RADIO CO., Inc.

4248 North Western Ave., Chicago, U. S. A.

FROST-RADIO

Ask Your Neighbor

FROST-FONES

No. 161 FROST-FONES. Drawn aluminum shells and composition caps. 2,000 ohm, Special head band $4.00

No. 171 FROST-FONES. Same as No. 161, aluminum shell type, but 3,000 ohm $5.00

No. 162 FROST-FONES. Composition shells and caps, improved design with reinforced terminal and cord. 2,000 ohm $5.00

No. 172 FROST-FONES. Genuine maroon moulded BAKELITE shells and caps with moulded in terminal block and special improved design. 3,200 ohm . $6.00

Your neighborhood dealer handles FROST-RADIO

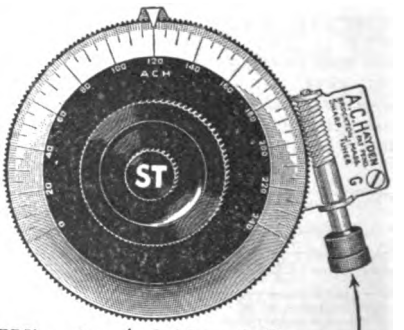
HERBERT H. FROST, Inc.

154 West Lake Street

CHICAGO

New York Kansas City, Mo.

A Pleasant Surprise Awaits the User of the A.C.H. Sharp Tuner Dials



Why the A.C.H. is different

3 in. DIAL ~~A.C.H.~~ 156-to-1

4 in. DIAL ~~A.C.H.~~ 215-to-1

Will improve any receiving set, making difficult tuning easy

Money Back Guarantee

Price 3-inch size....$2.50 Price 4-inch size....$3.00

Regular fitting 5/16 shaft ¼ and 3/16.....50c each extra

Extra Advantage of the A C H

1. Can be attached or removed from any instrument.
2. Rough tuning same as any dial.
3. Movement so fine that the eye cannot detect but the ear can.
4. Automatically locks instrument so no jar can disturb it.
5. Dial grounded reducing the body capacity to a minimum.
6. Special dial 2 graduations where ordinarily one.

MAIL ORDERS SENT PREPAID IN U. S. A.

A. C. HAYDEN RADIO & RESEARCH CO.

25 E. Battle St., BROCKTON, MASS., U. S. A.

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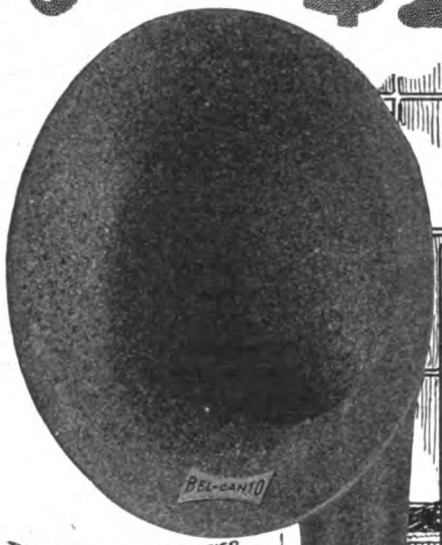
$25 for $10

The Famous BEL-CANTO Acoustical Amplifier

Direct from Manufacturer to you



THE ACOUSTICAL AMPLIFIER
BEL-CANTO
TRADE MARK

7 POINTS OF BEL-CANTO SUPERIORITY

1. Our own fiber horn. Crystalline finish.
2. Our own adjustable loud speaking unit, giving a wide range of tone quality and volume without distortion.
3. The base of cast iron, weighing four pounds, eliminating top heaviness.
4. All other metal parts are of heavy cast aluminum, highly polished.
5. Complete instrument stands 24 inches high, 10 inch bell.
6. Guaranteed for one year from date of purchase against mechanical defects of any kind.
7. No auxiliary batteries required. Just plug in on 2nd stage.

You cannot buy the BEL-CANTO from any dealer

Only direct from us. We save you these three profits DISTRIBUTOR, JOBBER and DEALER

Call at our factory, send us your check, money order, or pay the postman $10.00. Prepaid to any part of U. S. and possessions.

Tel. Vanderbilt 8959

C. O. D. Delivered to your door

GUARANTEE

Money back any time within ten days if dissatisfied. We further guarantee to the publication carrying this advertisement that each and every speaker sold will be exactly as advertised in this issue.

Price $10

BEL-CANTO MFG. CO.,

BENSEL-BONIS CO., Inc.
General Office and Factory, Dept. P. R. 417-419-421 East 34th St., N.Y.C.

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Your Choice! —for Only 35 Cents in Stamps!

Hundreds of reliable hook-ups and circuit diagrams—practical hints and handy knacks—money-saving tips and pointers on how to make and improve your own sets. Take your pick of all this authoritative information on radio!

PERHAPS you haven't realized what a tremendous amount of information is available in the back issues of POPULAR RADIO. Since the first number was published, May, 1922, literally hundreds of requests have come to us for these valuable back issues of POPULAR RADIO which contain so many practical hints and worth-while suggestions.

There are still a few copies left of many of these back issues. *While they last* you can take your pick of them at only 35 cents each, to cover cost and mailing. Here's your opportunity to complete your files of POPULAR RADIO and to add to your store of information on just the subjects which interest you.

Glance over this partial list of contents of each issue. Then tell us which ones you want, enclosing stamps, check or money order to cover your requirements. Our stock is getting very low, so don't delay taking advantage of this offer!

May, 1922

—Harnessing waves to wire.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How electricity is generated.
—Tones that do and don't broadcast.
—How to make a simple tube Receiving Set.

July, 1922

—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—How to make a variable condenser.

September, 1922

—How to build the Armstrong Circuit Receiver.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922

—How to make a spider-web tuner.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922

—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—The most popular transmitting aerial.
—How to make a novel variocoupler.

December, 1922

—How to select the best coil for your set.
—How to make and use a loading coil.
—A Receiving Set that takes notes.
—How to make a series-antenna condenser.

January, 1923

(Out of stock. A Reprint of Mr. Cockaday's article describing the DX Regenerative Receiver may be had for 22 cents.)

February, 1923 (Out of stock)

March, 1923 (Out of stock.)

April, 1923

—Regeneration without Radiation.
—How to make a simple single tube Receiving Set.
—Circuit diagram of the Cockaday DX-3 Circuit Tuner, with instructions on how to add three stages of radio frequency.

May, 1923

(Out of stock. A full description, however, of Mr. Cockaday's original 4-Circuit Tuner will be found in POPULAR RADIO'S handbook, "How to Build Your Radio Receiver," advertised on page 00.)

June, 1923

—How the microphone transmitter works.
—How to build a good single tube receiver.
—How to make a crystal detector stand.

July, 1923

—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

August, 1923

(Out of stock. A full description, however, of the Tuned Radio Frequency Receiver will be found in POPULAR RADIO'S handbook," "How to Build Your Radio Receiver," advertised on page 110.)

September, 1923

—How to get a radio license.
—How weak signals are regenerated.
—How to make a battery charging rectifier.
—How to build the Haynes DX receiver.

October, 1923

—Practical hints for Coil Calculations.
—How to make a Two-stage Audio frequency Amplifier.
—Ten good rules for Broadcast Listeners.
—How to make a simple Honeycomb Receiver.

November, 1923

—The 100 Best Hook-ups (Part 1)
—Receiving without Antennas.
—How to build the New Regenerative Super-heterodyne Receiver (Part 1.)
—How to build a combination Short and Long-wave Receiver.

December, 1923

—How to Select your Radio Parts.
—The 100 Best Hook-Ups (Part 2).
—How to Read a Diagram (Part 1).
—How to Build an efficient Crystal Receiver.
—How to Build the Super-heterodyne Receiver (Part 2).

January, 1924

—How to build the "Improved" Cockaday 4-Circuit Tuner.
—The 100 Best Hook-ups (Part 3.)
—How to Read a Diagram (Part 2.)
—List of U. S. Broadcasting Stations.
—How to build the coupler, oscillator coupler and r. f. transformers for the Super-heterodyne.

February, 1924

—How to add "Push and Pull" amplification to the original 3 tube Cockaday 4-circuit tuner.
—The original 4-Circuit Tuner as a Portable Set with Loop.
—The 100 Best Hook-ups (Part 4.)
—How to build a 3-tube Reflex. Receiver (Part 1.)

March, 1924

—Hoffman Transformer Measurement Chart.
—The 100 Best Hook-ups (Part 5)
—How to Build an Amateur Transmitter.
—A 3-tube Reflex Receiver (Part 2).

POPULAR RADIO, INC.

9 East 40th Street **Dept. 48** **New York City**

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The BELL Dial

For Best Results

you will want to use BELL sockets and dials in your new hook-up. The blue box guarantees the genuine BELL.

Bell Dials

Highly polished molded Bakelite, with clean sharp engraving. Brass bushings; out-of-sight set screws. 2, 3, 3½ and 4 inch sizes. A handsome dial that adds to the looks as well as to the efficiency of any set.

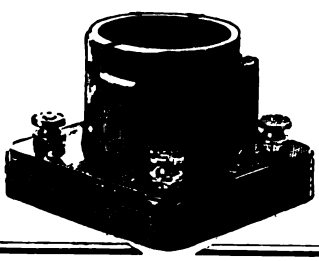
Bell Sockets

An unusual VT socket. Polished molded Bakelite, for base or panel mounting. Unique spring construction gives double wipe contact, ensuring perfect connection. No leakage or current losses. Ask for the BELL, the efficiency socket.

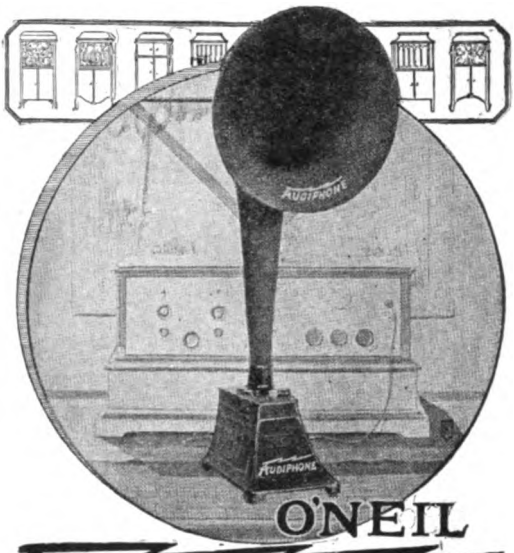
Dealers: If your jobber does not carry BELL Radio Products, write us for circular on molded sockets and dials.

Bell Manufacturing Co.

12 Elkins St. Boston 27, Mass.



The BELL Square Socket



O'NEIL AUDIPHONE

ART MODEL

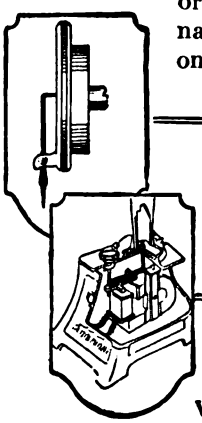
Beautiful Antique Bronze Finish. No extra batteries needed. Complete, with connecting cord.

$30

14 Inch Horn $5 additional

GENUINE Loud Speaker construction—not a magnified headset: a superior instrument conceived by phonograph craftsmen and radio acoustic engineers. Music and speech actually reproduced. A "laminated voice core" produces *all* of the original music. Exterior adjustment. Will not blast on most powerful circuits. Guaranteed to satisfy or full purchase price promptly refunded. Your dealer has the *Audiphone* or order direct, mentioning his name. Descriptive booklet on request.

Write for Literature



Note the similarity of construction between the phonograph reproducer (illustrated in the upper panel) and the reproducer of the O'Neil *AUDIPHONE* (below): both have a mica diaphragm set in a sound-box chamber actuated by an elbow stylus bar.

O'Neil Mfg. Co.

714 Palisade Avenue
West New York," New Jersey

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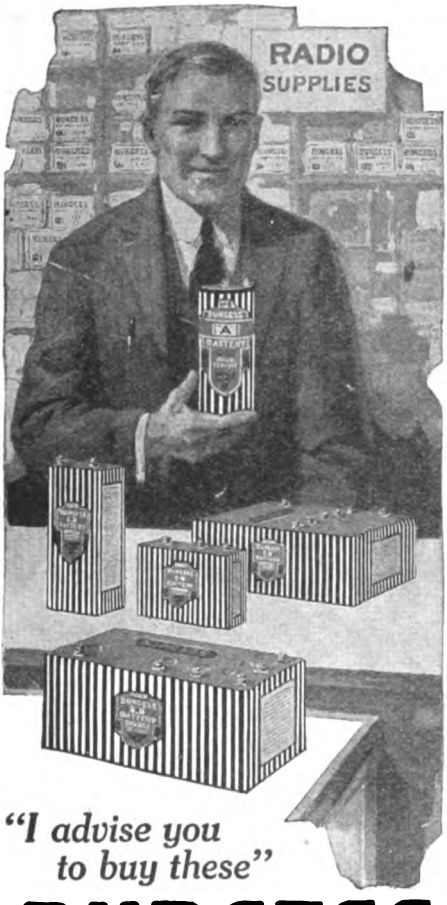


"I advise you to buy these"

BURGESS
RADIO BATTERIES

Long life, noiselessness, high capacity and smooth, uniform current discharge are qualities vitally necessary to clear reception and economical service. We believe Burgess Batteries offer an unequalled combination of these qualities. "Ask Any Radio Engineer."

Send for ***"The 'A' 'B' 'C' of Radio Dry Batteries."*** **If you are a user of dry batteries in radio service you will find this *book of instructions* crowded with authoritative information and suggestions. As a handy reference and buying guide, it is well worth the few moments spent in sending for it.**

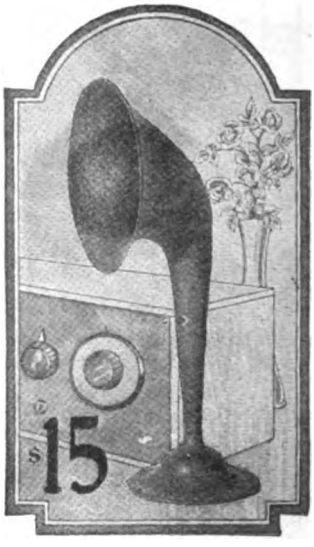
BURGESS BATTERY COMPANY
106 Washington St., Madison, Wisconsin
Please send me free of charge a copy of the booklet, "The 'A' 'B' 'C' of Radio Dry Batteries."

Name _____

Street _____

City _____ State _____

Perfectone



FAMOUS for Performance
ATTRACTIVE in Appearance
POPULAR in Price

It is refreshing to hear a Perfectone as its tone convinces you of its superiority.

Before you purchase a loud speaker or phonograph attachment at any price, see and hear the Perfectone.

At your dealers, otherwise send purchase price and we will supply you postpaid.

Phonograph Attachment
$8.75

Perfectone Radio Corporation
490-C Broome St., New York

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Na-ald No. 499

Na-ald Small Space
No. 401

Cross Section
De Luxe Socket

Na-ald No. 411

Na-ald
Adapter No. 429

Na-ald De Luxe
No. 400

NA-ALD

IT'S THE CONTACT THAT COUNTS

Na-ald Sockets

Na-ald De Luxe
No. 400
Price 75c

Na-ald Socket, No. 499
Price 50c

Na-ald Adapter, No. 429
Price 75c

Na-ald W D 11 Socket
No. 411
Price 75c

Na-ald Small Space
No. 401
Price 35c, 3 for $1.00

Na-ald sockets embody features which make for thoroughly dependable contact under all conditions. This fact has won for them the place of leadership among radio sockets.

Each contact strip in Na-ald sockets is of a wiping nature, maintaining contact over a broad surface, and so designed that strong, permanent tension is assured.

All Na-ald sockets are moulded of Bakelite, with uniform cross-section and cure. These, with other engineering features, avoid plate to grid losses and insure the development of full efficiency in tubes.

Write for "Why a Bakelite Socket" and other descriptive literature

ALDEN MANUFACTURING CO.

Dept. C. **52 Willow St., Springfield, Mass.**

Bakelite Jack

No. 30-Single circuit open $.80
No. 31-Single circuit closed .85
No. 32-Double Circuit ..... .90
No. 33-"A" Battery Switch .90

2-Way Plug

Price 60c

Every CICO PRODUCT is packed in a distinctive GREEN BOX and unqualifiedly guaranteed against all defects.

Approved and Used by Experts and Amateurs

CICO Jacks moulded from Bakelite—no metal in frame construction. Connections made to Binding Posts—no soldering necessary. Phosphor Bronze Springs—will last a lifetime without adjustment. Direct connections to springs—insure perfect contacts. Sterling Silver Contact Points.

CICO

CICO 2-Way Plugs constructed so that loud speaker and headphones can be connected simultaneously or individually whichever you desire. Fit all standard jacks. Take all types of tips, forked, straight, and plain wire.

Consolidated Instrument Co. of America, Inc.

41 East 42nd Street, New York

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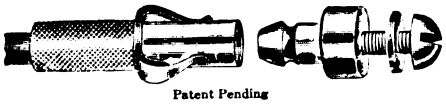
RAJAH SOLDERLESS SNAP TERMINALS

For Aerial, Ground and Battery Connections



Patent Pending

Instantaneous in Operation—Positive Contact

Patent Pending

SOLDERLESS ATTACHMENT TO WIRE

Just push removable part, attached to wire, on the base stud and it snaps into place making a positive electrical connection.

To remove, just pull it off; no screws to bother with; no springs to bruise the fingers.

A positive electrical connection in ten seconds, without solder or tools, that cannot pull out or shake loose and is as easy to remove as it is to assemble to the cable.

Base studs secured by No. 8-32 screws and will fit all "B" batterie with screw posts.

Rajah Snap Terminals allow instantaneous change in place voltage with a secure connection, better than any switch.

No owner of a radio set who has seen or used a Rajah Snap Terminal will ever use any other style of binding post.

Price, Snap Terminal and Base Stud, complete as illustrated, each 20c.

Base studs are sold separately as they can be used wherever a change of connection is desired, thus permitting a quick change of lead in and battery wires from one set to another.

Base studs with screw and washer, each 5c.

Special Introductory Offer: 1 Dozen Snap Terminals and Base Studs complete by mail prepaid, $2.00.

Dealers get in line at once for the best-selling radio device you ever saw.

RAJAH AUTO SUPPLY CO. BLOOMFIELD NEW JERSEY

Parts

for all POPULAR RADIO Circuits

WE SPECIALIZE in supplying parts for hook-ups described in this magazine. All orders sent to us will be filled promptly, with all parts exactly as specified.

Mail orders will be filled at the right prices and C. O. D. shipments gladly handled.

This is your opportunity to establish a reliable purchasing connection in New York where all radio supplies can be quickly secured for you.

Morison Electrical Supply Company

15 East 40th Street **New York City**

The New

B-T Synchrodyne

is "The Hook-up you Hoped for"

We confidently believe it surpasses any 4 or 5 tube R. F. Circuit yet developed—

Ask your dealer or send 2c for folder

BREMER-TULLY MFG. CO.
534 S. Canal St., Chicago

$4.50 List

$4.50 List

"ROYALFONE"

KING OF ALL

Tune in those distant stations with a pair of "Royalfones."

JACK BINNS, says, "They will give an audible sound with a weaker signal than the average phone."

That is why you will get distance where you don't with your present pair.

If your dealer can't supply you, write direct.

Royal Electrical Laboratories
Dept P. R., Newark, N. J.

Royalfone
KING OF ALL

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MARLE

Radio & Audio Frequency

TRANSFORMERS

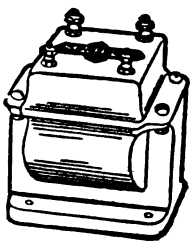
"The Heart of a Good Receiver"

EQUAL to the widest range of reception requirements. **Marle Transformers** amplify the weakest broadcasting, over frequencies all the way up to 3500 cycles without variation. Perfect tone quality. Utter absence of howling or distortion. To get the most out of radio—use **Marle Transformers.**

Specially adapted to the latest circuits, the SUPERDYNE, SUPERHETERODYNE, FOUR-CIRCUIT TUNER, NEUTRODYNE, INVERSE DUPLEX and any circuit that makes high requirements of a transformer.

Type A4
Ratio 3¾ to 1
$3.75

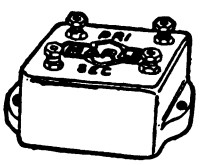
Type A6 Audio F
Ratio 5 to 1
$4.25



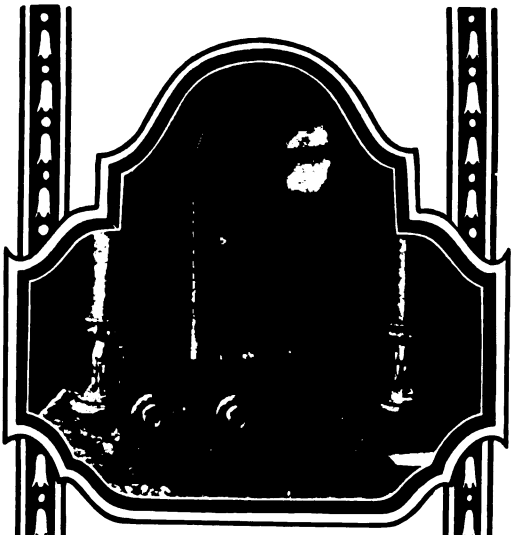
MARLE Engineering Company

Orange New Jersey

Audio F Shelltype Type A7
Ratio 3¾ to 1
$4.50



Radio F Types R1 and R2
$4.00



RADIODYNE

"The Voice of the Nation"

NO LOOPS — NO ANTENNA

The air is your theatre, college, church and newspaper if you own a Radiodyne. New York, Cuba, San Francisco and Honolulu can be picked up clear and distinct without interference from nearby stations.

The Radiodyne is ready for operation by simply grounding to a water pipe or radiator, and throwing a few feet of wire on the floor. Uses any standard tubes—dry cell or storage battery. Extremely selective. Simple to operate—***Only two controls***—you can tune in on any program you select—any wave length from 200 to 700 meters.

For use in apartments, boats, automobiles, railroad trains, etc., the RADIODYNE is enjoyable where other receiving sets would not be practical.

Price, $150.00

Write for illustrated folder which describes the RADIODYNE in detail. Every radio fan will be interested in this new type (antennaless) receiving set

WESTERN COIL & ELECTRICAL CO.
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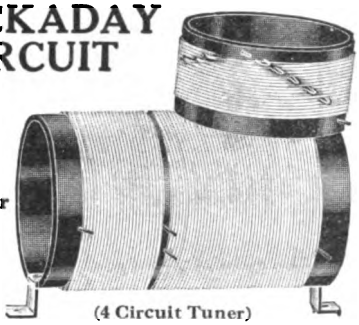
EASTERN COIL SETS

for the **COCKADAY CIRCUIT**

are the Standard, and in Universal Use due to their Proved Efficiency in this wonder circuit



(4 Circuit Tuner)

Made as per specifications of Mr. Cockaday, "D" Coil bank-wound.

Complete assembled Set of B, C and D Coils on GENUINE BAKELITE TUBING, wound with #18 double silk covered wire **$4.25**

Original and new improved hook-ups with material lists FREE with each set of coils.

GENUINE LAVITE RESISTANCES, 48000 ohm, each **$1.50**

These resistances *control* the *tone* of the Cockaday Circuit and eliminate all transformer distortion; modulating the tone after the fashion of the best of phonographs.

Mail Orders Filled. Dealers Communicate.

EASTERN RADIO MFG. CO.

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The TRINITY LOUD SPEAKER

TYPE AI
$25.00
21" Fibre Horn

The Trinity Loud Speaker is an instrument that combines the best qualities of a phonograph reproducer in combination with electro-magnetic principles best fitted for radio amplification.

Perfect reproduction of all music and speech without distortion. No storage batteries required. The instrument is of a heavy duty type and is guaranteed fully by the manufacturers.

For sale by good dealers
Literature upon request

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"Push-Pull" Crescent Transformers

Experts admit "Push-Pull" amplification gives greatest satisfaction. The Crescent is a high grade Transformer. Specially designed to give maximum amplification on the new and improved circuits. Perfectly balanced. Gives clearer tones, reducing distortion to a minimum. Crescent "Push-Pull" Transformers are sold in matched pairs at $8.50 per pair. Complete diagram, hook-up, list of necessary parts, all sent free with each pair. Crescent Audio Transformers, 3½ to 1 ratio, specially designed for 2-step amplifier to match above "Push-Pull" at $2.95 each. At your dealer's or sent postpaid on receipt of price. Satisfaction guaranted.

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Pity the Bug Who Has None!

THE fellow who tinkers and fools around all kinds of adjustments in order to eliminate back alley discord will appreciate this tip regarding Reliable condensers for all tuned radio circuits. You get smooth sounding messages and concerts without difficulty and numerous other advantages with this little device.

The Reliable Parts Mfg. Co.

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Reliable

neutralizing condensers

Edson

TONE TESTED

Radio Headsets

YOU can afford to have several at this price. Our guarantee protects you. Equal to any headset on the market in perfect reception of broadcasting. Send $3.00 by registered mail or money-order. We will ship C.O.D., if you prefer. Prompt shipment—we pay postage. Ask for our

Free Catalog of Radio Parts

EDSON RADIO SALES CO.

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RADIO TUBE EXCHANGE

We Repair All Standard Makes of Tubes, Including

W.D. 11 or 12
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C. 11 or 12
U.V. 201A or C. 301A
D.V. 1 or D.V. 2
U.V. 200 or 201
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$2.50

All tubes guaranteed to do the work

RADIO TUBE EXCHANGE

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All Mail Orders Given Prompt Attention
Orders Sent Parcel Post C. O. D.

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As You Gaze at the Stars—

The gentle calm of a bright starry night fills us with mystery. Little did we dream a while back that today, far and wide in the unknown, thousands of voices, hurled by electrical energy, are rushing at unheard of speed through space to all points of the compass.

A person here, a group there—in fact, in a million or more homes people are anxiously tuning in on their radios, groping in the air, hoping to catch the sound of a far-away station. Scarcely a sound, a slight turn, a faint noise, another adjustment and then clear and clearer comes voices, a quartet is singing; so clear and distinct comes the soft gentle melody that the listeners close their eyes, the singers seem to be in the very room with them.

If you desire clearer reception, greater volume and the elimination of howling and distortions, install Jefferson transformers in your set.

There's a Jefferson Transformer for every circuit

Write for amplification data and interesting descriptive literature.

Jefferson Electric Mfg. Co.
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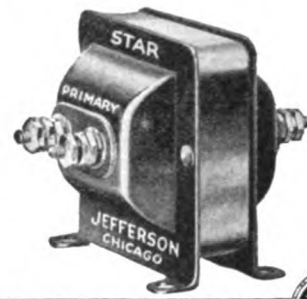

An Absolute Guarantee with every instrument made them famous!

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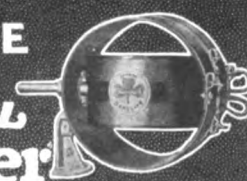
FOR SELECTIVE TUNING

180° Vario-Coupler

list price, $3.50 *each*

DOUBLE DUTY PIG-TAIL
Variometer



SHAMROCK MFG. CO.
314 E. Market St. — Newark N.J.

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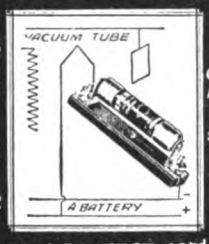
AMPERITE
THE SELF ADJUSTING RHEOSTAT
FOR AMPLIFYING TUBES
$1.10 WITH MOUNTING



ELIMINATES HAND RHEOSTATS
SAVES YOUR TUBES
ASK YOUR DEALER
GIVES LOUDER AND CLEARER MUSIC
SIMPLIFIES WIRING
GREATER DISTANCE

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NEW YORK

RADIO PIN-MAP
of United States, Canada and West Indies with indexed booklet Broadcasting guide.
Spot Stations You Hear with Colored Map Pins
Map size, 22x14 in., mounted on map-pin board. Shows all broadcasting cities, distance scale, relay and time divisions. Guide gives all call signals, locations, stations, wave lengths, etc. Price complete, 85c. Map-pins, 10c per doz. Any color. Above booklet with folded paper map, 35c. At your dealer or direct.
AMERICAN MAP CO.
MAP MAKERS PUBLISHERS
Maps of Every Description
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Representatives wanted.

FREE RADIO SET
WONDERFUL RECEIVING SET!
Complete, including head phones serial, ground wire, insulators, etc. Just hook up and listen in on Concerts, Sport Returns, Lectures, etc. No batteries needed.
COMPLETE WITH HEAD PHONES ETC.
ABSOLUTELY FREE
Rush name and address for Free Radio Plan
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READY TO LISTEN IN

BURNT OUT RADIO TUBES
Repaired by us guaranteed to be equal to new. We have convinced hundreds, why not you? All Tubes $2.75 with the following exceptions: 201A—301A—199 299, which are $3.00.
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Improves any crystal. Gets greater distance. PURE GOLD makes the best contact known. We guarantee a GOLDWHISKER to get greater range and louder signals out of any crystal. 50c prepaid—send coin or stamps, or we'll send C. O. D.
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Dept. N-1 3231 Nebraska Ave., St. Louis, Mo.

Free to You!

--Your Choice of a set of Blueprints

POPULAR RADIO makes a special 30-day offer of a set of three full size Blueprints *free*. You may take your choice of the set covering the "Improved" Cockaday 4-Circuit Tuner, or the set covering the Non-Regenerative Tuned Radio-Frequency (Neutrodyne) Receiver.

Either of these sets of Blueprints will come to you postpaid, absolutely free of charge, if you take advantage of this short-term offer.

Each set of three prints includes an actual size panel pattern, an instrument layout, actual size, and a *picture diagram showing all wiring connections*. These Blueprints are announced on another page of this issue of POPULAR RADIO at their retail price of $1.10 per set.

But by availing yourself of this special offer now, you get your choice of either set *free* with your yearly subscription to POPULAR RADIO at $3—the price of the magazine alone.

You know how helpful and interesting POPULAR RADIO is. A year's subscription will bring you a multitude of hints and practical pointers that will make a world of difference in your enjoyment of radio. And with either set of these Blueprints—offered to you free—you can construct one of the most highly-efficient radio receivers that can be had.

Fill out the handy coupon today. Your subscription will be entered to start with the May issue, and your set of Blueprints will come to you by return mail.

POPULAR RADIO, Inc.
9 East 40th Street, New York City

POPULAR RADIO, INC., Dept. 43,
9 East 40th Street, New York City

I enclose $3 in full payment of a year's subscription to POPULAR RADIO starting with the May number. Please send me absolutely free of charge, postpaid, a complete set of three actual-size Blueprints for the Receiver checked below:

☐ "Improved" Cockaday 4-Circuit Tuner.

☐ Non-Regenerative Tuned Radio-Frequency (Neutrodyne) Receiver.

Name.....

Address.....

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(No extra for Canada. Foreign countries 50c magazine postage extra.)

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REMEMBER THIS ABOUT RADIO LOUD SPEAKERS—

that no matter what type of loud speaker you have bought or intend to buy eventually you will come to a cabinet type—

FOR

—Loud Speakers will follow the phonograph in developing into beautiful furniture.

—And Timmons Talkers are the most beautiful loud speakers in the world.

For tone, volume and clarity we ask you to hear either type A (adjustable) $35, or N (non-adjustable) $25 at your dealers, or in your own home.

We, or any of our representatives, will send a 17 x 22 inch folder showing what is inside and your dealer will give you a "Volume without Noise" folder.

J. S. TIMMONS
339 E. Tulpehocken St.
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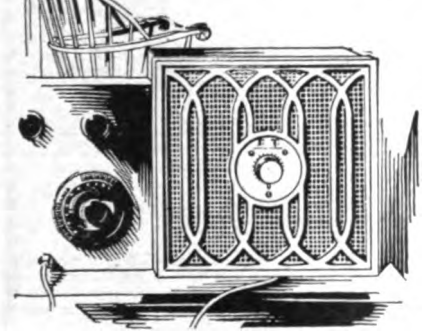


Timmons Talkers

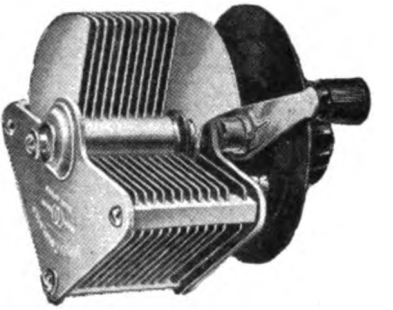
In any circuit where a Variable Condenser is specified, select the one condenser that insures absolutely faultless reception.

THE DUPLEX COMPACT PRECISION

TRADE MARK

NONE OTHER

CONDENSER



Built as nearly as is commercially possible to specifications of U. S. Bureau of Standards.

Knob and Lever Vernier Control.

Maximum-Minimum ratio of 23 Plate Vernier 60 to 1.

Die-cast Rotor—Milled Stator.

Awarded approval by "Radio Broadcast."

SPECIFICATIONS OF ALL MODELS

Model	Total No. of Plates	Max.Cap. Mfds.	Min.Cap. Mfds.	Ratio Max./Min.	List Price
DR-3	3	.00005	.00001	5/1	$1.00
DR-11	11	.00024	.00001	24/1	2.00
DR-11V (Vernier)	14	.00029	.00001	29/1	2.50
DR-13	13	.00029	.00001	29/1	2.25
DR-13V (Vernier)	16	.00034	.00001	34/1	3.00
DR-17	17	.00040	.00001	40/1	2.35
DR-17V (Vernier)	20	.00044	.00001	44/1	3.25
DR-23	23	.00055	.00001	55/1	2.50
DR-23V (Vernier)	26	.00060	.00001	60/1	3.50
DR-43	43	.00103	.00002	51.5/1	3.50
DR-43V (Vernier)	46	.00115	.00002	57.5/1	4.00

Prices on vernier including knob and lever but not the dial.

Send us the name of your dealer and jobber.

Write for pamphlet "Taking the CON" out of condensers. It contains facts you should know.

JOBBERS send for distributor's proposition.

The Duplex Engine Governor Co., Inc.
50 Flatbush Ave. Extension, Brooklyn, N. Y.

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GLANCE over this big list of magazine bargains that have been arranged for your benefit. Here is your chance to get almost any magazine you want—and by ordering *now* with a year's subscription to POPULAR RADIO you get *both* magazines at special low prices.

If you are already a subscriber to POPULAR RADIO or to any of these other magazines, these special club offers allow you the privilege of renewing or extending your present subscription for an additional year *at a considerable saving of money.*

Fill your magazine requirements *now* for the coming year and save money. Simply check the offer you want and mail the coupon below, with your remittance, without delay.

All subscription prices quoted are for one full year, and may be sent to *one* or to *separate addresses* unless otherwise noted. (Club prices for Canada and foreign countries will be quoted on request.)

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TRADE MARK-PATENTS GRANTED AND PENDING

NON-RADIATING DX COUPLER

Combination Flat and Bank Wound

150 to 1000 Meters
Guaranteed Wave Length

Set of six efficient hook-ups packed with every "All Wave" Coupler or mailed on receipt of 10c in stamps to cover cost of mailing.

All the SELECTIVITY of TUNED RADIO FREQUENCY at a SMALL FRACTION OF ITS COST. Like its companion the 3000 meter Capitol "All Wave" Coupler, Sr., it may be used in a single circuit with the added feature that it may be used in a double or triple circuit.

Used in the "All Wave" triple circuit, the "All Wave" Jr. is guaranteed not to radiate and to bring in distant stations clear and loud on one tube. Log your stations and get them at the same setting every time. Only one dial to tune.

"SHEPCO" "ALL WAVE" JR.

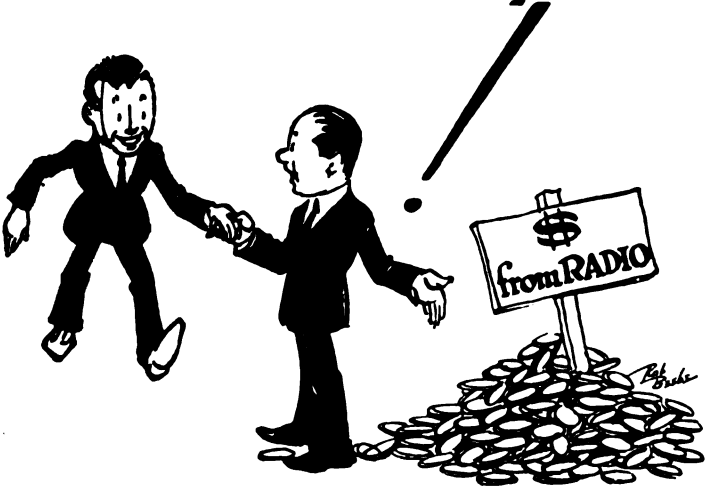
Eliminates use of all variometers, vario couplers and loading coils. Permits building most efficient, sharp tuning, loud long distance receiver at lowest cost.

ON SALE AT ALL DEALERS IN STANDARD RADIO PARTS OR SENT DIRECT ON RECEIPT OF PRICE. ABSOLUTE MONEY BACK GUARANTEE **$6.00**

SHEPARD-POTTER CO., Inc.

Plattsburgh, N. Y.

Let HOMMEL'S experience guide you



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HOMMEL distributes only recognized nationally advertised apparatus that is guaranteed by the manufacturer—their dealer discounts are very liberal—their stocks are always ample to take care of any requirement—they wholesale exclusively and do not compete with dealers by retailing.

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Get in touch with us today, write for the new HOMMEL ENCYCLOPEDIA, 246-P— profit by Hommel's experience —it is paying hundreds of other dealers —why not you?

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AT FACTORY PRICES

Greatest radio "B" battery on market. Full number voltage taps; QUALITY GUARANTEED; LOWEST PRICES; brings in concerts LOUDER AND STRONGER; will work on any tube or loud speaker. Order by number TODAY with check, money order or pay postman C. O. D.

No. 122B 22½ volt variable, regularly $2.25... **$1.52**
No. 122A 22½ volt variable, regularly 3.00... **1.85**
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A complete set at a special price.

And they're EBY posts, so the tops don't come off.

Your dealer will have them and will show you other popular markings.

$1.50 per set

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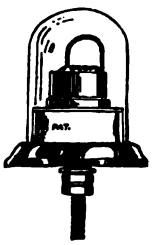
Most sensitive spot found and *fixed* at the factory. Glass enclosure protects crystal from dust, moisture and vibration.



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THE NEW SIMPLEX

180° Vario-Coupler
With a Special Woven Rotor

will bring in those distant stations you are trying for. An exceedingly efficient and neat coupling device combining all of the best features that have been developed in the past year and which will cover all broadcast wave lengths up to 600 meters.

Price - - $3.50

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WD-11, WD12, UV-201A, UV-199, And others for $2.50

Quick service. All tubes repaired by us guaranteed to work as good as new.
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The artistic qualities of Na-ald De Luxe dials distinguish these dials as truly beautiful. They add to the appearance of any set in which they are used.
Na-ald Dials have a high gloss finish. They are moulded of genuine Bakelite and have patented construction. Dials are matched and made in 2", 3", and 3¾" sizes.

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35c, 3 for $1.00

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The COCKADAY 4-CIRCUIT TUNER

	List Price		List Price
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1 Precision Cockaday Coil	5.50	1 Pacent Single Jack	.60
2 Amsco 26 Pl. Cond. 4" Dial	11.00	2 Amertran Transformers	14.00
5 Melco Tube Sockets	5.00	2 Amsco Switch Levers	.60
1 Amsco 6 Ohm Rheostat	1.00	3 48,000 Ohms Lavite Resistances	3.75
3 Amsco 20 Ohm Rheostats	3.75	1 .00025 Dubilier	.45
2 Amplex Grid Densers	2.50	1 .0005 Dubilier	.45
1 Durham Var. Grid Leak	.50	1 Pr. Como Dup. P. P. Transformers	12.50
1 Amsco 400 Ohm Potentiometer	1.50	1 Panel 1x12	.40

GENUINE COMPLETE PARTS as listed above for the **Improved Cockaday 4-Circuit Tuner**. Exactly as specified by Mr. Cockaday List price $69.00. SPECIAL KIT PRICE **$55.00**

The above parts may be bought separately. Write for our catalogue

Orders over $5.00 Shipped Prepaid, Money Orders or C. O. D. One-third must accompany all C. O. D. orders. Not insured unless insurance charges included.

Please refer to POPULAR RADIO *when answering advertisements.*

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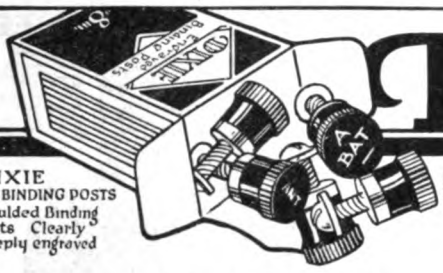
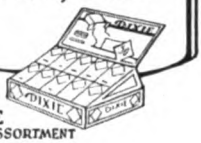
DIXIE



DIXIE
ENGRAVED BINDING POSTS
8 Moulded Binding Posts Clearly and deeply engraved

DEALERS ~ Write about these attractive display cartons.



You Need These!

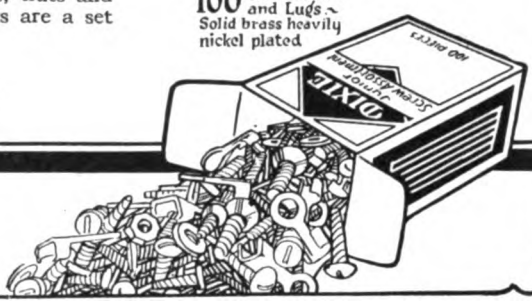
If you're building a set these two DIXIE products will make things immeasurably easier for you. No more hunting for screws! No need of using inferior binding posts!

The DIXIE Junior Screw Assortment contains 100 pieces of essential radio hardware—screws, nuts and lugs. The DIXIE Engraved Binding Posts are a set of 8, moulded and beautifully engraved.

The price of each is only 50c per box!

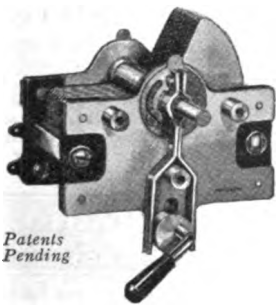
SEND FOR BOTH TODAY

DIXIE
JUNIOR SCREW ASSORTMENT
100 Screws, Nuts and Lugs ~ Solid brass heavily nickel plated



DIXIE SUPPLY CO.
91 Seventh Ave. N.Y.C.

New Model "B" HAMMARLUND



Patents Pending

Vernier Variable Condenser
SHARPEST TUNING—MINIMUM LOSSES
Will Increase Your Range and Volume—Eliminates Interference
Grounded Panel—Brass Plates
PRICES FOR PANEL MOUNTING

43 Plate .001 Mfd. . . $7.00	17 Plate .00037 Mfd. . . $5.75
23 Plate .0005 Mfd. . . $6.00	13 Plate .00025 Mfd. . . $5.50

3½" pure Bakelite Dial $.75
4" pure Bakelite Dial $1.00

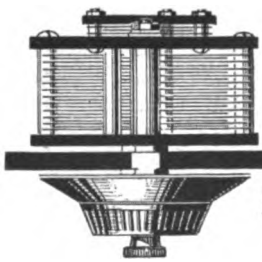
At your dealers—otherwise send purchase price and you will be supplied postpaid.
Write for New and Interesting Folder

HAMMARLUND MFG. CO.
144-146 W. 18th St. New York City

RATHBUN
SINGLE-HOLE MOUNTING
SUPERIOR CONDENSERS

Special—13 Plate
NEUTRODYNE
CONDENSERS

Every requirement which the Hazeltine Neutrodyne circuit makes of a condenser is perfectly met in this special Rathbun Condenser. ***Single hole mounting*** and ***full Bakelite disc end-plates,*** reduces capacity to insignificant minimum. No iron or steel parts. So much of the success of your Neutrodyne receiver depends on accurate condensers that you should insist upon the name RATHBUN.



Capacity
.0003 MFD
LIST
$3.00

Write TODAY for the name of the nearest **Rathbun** dealer and for illustrated literature

RATHBUN MFG. CO.
Jamestown, N. Y.

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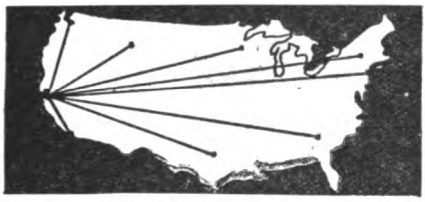


ON ONE TUBE

Broadcasting from Atlantic Coast, Canada, Mexico, Cuba & Hawaii heard in Calif. by users of the CROSS COUNTRY CIRCUIT. Range due to simplicity. One tuning control. ANY NOVICE can build easily and cheaply. Dry cell tubes used. No soldering. Complete instructions, Blue print panel layout, Assembly Photo, etc., postpaid 25 cents. Stamps accepted.

VESCO RADIO SHOP, Box PR-117, OAKLAND, CALIF.

---

2 Transformers for the price of 1

NEUTRODYNE

No Distortion
Greater Volume
Half-Price

For $6 we will send postpaid TWO of the famous Globe Audio Transformers made especially for Neutrodyne sets.

MONEY BACK GUARANTEE

If you are not fully satisfied with the transformers, return them within 5 days and your money will be refunded.

COYNE RADIO SERVICE
Suite 603
507 Fifth Avenue, New York City

WE REPAIR
The Following
RADIO TUBES

WD-11	$3.00	DV-6A	$3.00
WD-12	3.00	UV-199	3.00
UV-200	2.75	C-299	3.00
UV-201	3.00	UV-201A	3.00
C-300	2.75	C-301A	3.00
C-301	3.00	Marconi	3.00
DV-6	3.00	Moorhead	3.00
DV-1	3.00	6v.Plain Detector	2.75
DV-2	3.00	6v.Plain Amplifier	3.00

Mail orders solicited and promptly attended to.
Dealers and Agents Write for Special Discount.

H. & H. RADIO COMPANY
Clinton Hill Sta. P. O. Box 22-E. Newark, N. J.

Charge Your Battery For A Nickel

The Gold Seal Homcharger

charges Radio and Auto Batteries at home **overnight** for a nickel. Your dealer has it. Write for FREE booklet and list of broadcasting stations.

The Automatic Electrical Devices Co.
132 West Third St., Cincinnati, Ohio

The Sodion Tube

Type S-12 "THOROBRED" *Socket*

$1.00

Radio fans call this standard tube socket "the most beautiful socket on the market." Thick nickel-plated and hand-polished tube, tube fits snug, genuine Bakelite molded base, leakage cut to a minimum. Contact springs of finest phosphor bronze set at correct angles. $1.00.

If your dealer can't supply you with "Thorobred" Socket, send money order direct to us. Ask about "Read'em" Binding Posts and "Minute Man" Switch Levers.

The MARSHALL-GERKEN Co.
Dept. J. 27 No. Ontario St. Toledo, Ohio

CELERUNDUM
TRADE MARK
"The Crystal With a Soul"
(Reg. U. S. Patent Office)

Reception
Louder
Clearer
More
Natural

Functions with any conductor.
No special Cat-Whisker necessary
Will not burn out **50c**

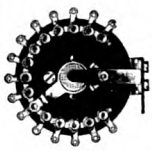
Celerundum "DE-TEX-IT"

A perfect fixed detector
Needs no adjustment **$1.25**

Celerundum Products carry a
MONEY BACK GUARANTEE

Celerundum Radio Products Co.
170 Summer Street, Boston

CARTER
Inductance Switch
(1-15 Points)



$2.00
Send for catalog

Original design. Solder terminal and contact one piece. Numbered Knob dial. Pig tail connection. Positive contact. Only one hole to drill. Carter quality throughout.

Carter Radio Co.
1807 REPUBLIC BUILDING
CHICAGO

Write fo free booklet:

"HOWTO SOLDER RADIO SETS"

For radio-frequency results use
SOLDER-BOTTLE FLUX and
PROFESSIONAL BRAND ROSIN-CORE SOLDER
as therein described.

THE VALLEY FORGE CHEMICAL CO.
Valley Forge, Pa.

MONEY
"I Earn $50 to $83 Weekly"
At work nicer than Movies
$5 to $10 made daily while taking Lowest-cost, Simple-to-learn, Fun-giving, Personal Radio Instruction. First 4 jobs pay instruction cost. Be an expert by MARVELOUS NEW METHOD. Pay by installment. Write for details
JAMES A. DOWIE, R.E.
D-694 RADIO, VA.

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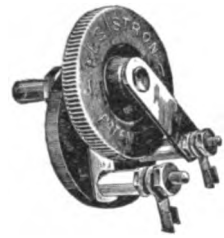
RESISTRON

Its the MERCURY that does the TRICK

Precision Variable Grid Leak $2.00 everywhere

Refinement—that's the keynote of perfect reception. You use vernier condensers and 180° couplers. But how about your grid leak? Does it have a 340° range like RESISTRON? Can you go back and repeat a dial setting and be sure of the same results? Does it do its work properly?



Rear view—showing panel mounting and supports for grid condenser

RESISTRON is built to give you a refinement of grid control suited to the extremely sensitive detector tube. For the adjustable contact with the high resistance elements, mercury is used—combining accuracy of setting with quiet operation. Reliability for all time is assured by sealing the active parts in an air-tight case.

Put on RESISTRON *- and go to the* COAST

Each instrument tested. Look for inspector's serial number on label — it's your guarantee of perfect satisfaction.

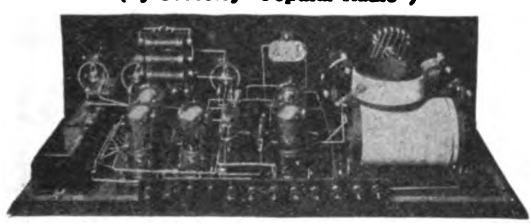
RESISTRON positively will adjust your detector grid to greatest sensitivity. Back your set to go its limit.

If your dealer cannot supply you, we will ship parcel post, C. O. D.

TEMPLE INSTRUMENT CO. Camden, N. J.

3000 MILES on a Loud Speaker

(By Courtesy "Popular Radio")



Build Your Set The Amplex Kit Way SAVE 1/3

with COCKADAY IMPROVED 4-CIRCUIT KIT

For Greater Distance — Clearer Signals

"GRID-DENSER"
(Variable condenser, 0 to .0005 mfd.)

Specified by Cockaday. Absolutely essential to control oscillations. Will improve any circuit. With Kit, or separately, $1.25.

48,000 Ohm Genuine "Lavite" Resistances, each, $1.25

FREE *Our engineers will answer any Radio questions, or help you with any wiring or assembling problems. This service is absolutely FREE to our patrons. Just write to Service Dept.*

HERE IS PROOF

Gentlemen: Let me congratulate you on your Cockaday Kit. A set constructed from your parts during the course of the first evening picked up 34 stations including KHJ (Los Angeles) all on the *Loud Speaker*. It sure is easy to construct a set from your "KIT." *L. Newman, Harrison, N. J.*

Dear Sirs: I have made exhaustive tests of the Improved Cockaday Four Circuit Tuner, and the outstanding improvement to my mind is the AMPLEX "GRID-DENSER."

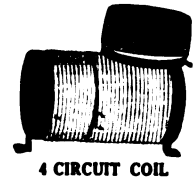
Using a set constructed from your "KIT" I logged over 45 stations including KFI (Los Angeles) and PWX (Havana.) I only logged those heard on a *Loud Speaker*. *H. Jawets, E. E., Consulting Engineer, New York.*

	List Price	Kit Price
1 Tube Cockaday Kit	$31.50	$24.75
3 Tube Cockaday Kit	54.30	42.50
5 Tube Cockaday Kit (Push Pull)	70.85	56.50

Parts	List Price Each
1—Panel 7" x 24" Drilled	$6.00
1—4 Circuit Coil	5.00
2—Amplex 24 Pl. Vari. Cond.	5.00
5—Amplex Sockets	.75
1—6 Ohm Amplex Rheostat	.75
3—20 Ohm Amplex Rheostat	1.00
2—Grid-Densers	1.25
2—Grid Leaks, Var.	.75
1—Amplex Improved Jacks S.C.	.65
2—Amplex Improved Jacks D.C.	1.00
2—Amplex Transformers	5.00
2—Switch Levers, etc	.50

Parts	List Price Each
3—48,000 Ohm Res.	$1.25
1—Res. Mounting	1.25
1—.0005 Mica Cond.	.45
1—.00025 Mica Cond.	.45
2—P. P. Transformers, pr.	12.50
1—Potentiometer	1.00
1—Baseboard	1.50
1—Set of plans (blue print)	1.50
12—Binding Posts	.10
Bus bar, etc	.50

AMPLEX INSTRUMENT LABORATORIES
Desk P.R. :: 57 Dey Street, New York, N. Y.



4 CIRCUIT COIL

Built strictly according to Cockaday's specifications. Bakelite tubing, No. 18 DSC wire..... **$5.00**

DRILLED PANEL AND COMPLETE BLUE PRINT INSTRUCTIONS

for wiring and assembling with each Kit. No special skill or technical knowledge required. Safe and Simple.

Every part in every Kit is tested, guaranteed. Individual parts may be purchased separately at list price.

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POPULAR RADIO Invites You to a Birthday Party

ON April twentieth, POPULAR RADIO will celebrate its birthday. On that date the magazine will be *two years old.*

Probably few magazines in the history of publishing have *so rapidly* attained pre-eminence in their fields, as has POPULAR RADIO.

Those of our readers who remember the first issue of POPULAR RADIO, published in May, 1922, will recall that the magazine at that time was barely more than pamphlet size.

Since then, POPULAR RADIO has grown steadily and rapidly to its present size and importance. Today POPULAR RADIO has *more subscribers than any other radio magazine whose net paid circulation figures have been reported to us.*

From the day of its first publication, POPULAR RADIO has maintained strictly and consistently the open policy of giving its readers *accurate and authoritative* facts and information. No expense has been spared to make sure that the hook-ups printed are *practical and will work.* POPULAR RADIO'S "how to build" articles have become famous. Our exclusive articles by leading scientists of world-wide reputation, telling "how radio works," have been quoted in technical journals and in scientific circles both here and abroad. The scores of practical hints published in every issue of POPULAR RADIO on "how to get the best results" have enabled millions of radio novices and amateurs to attain greater enjoyment and satisfaction from their equipment.

Yet with all of its phenomenal growth, there are still many radio enthusiasts who have yet to appreciate the pleasure and value that can be derived from POPULAR RADIO. And in order that this magazine may be brought to *their* attention we are now making a special 30-day Birthday Offer.

Here is our offer—in a nutshell.

If you, who are a reader of POPULAR RADIO, will secure the subscription of some friend or acquaintance who is *not* a regular subscriber, we will reward you by entering or extending *your own subscription* for a period of six months absolutely free of change. In other words, you get a six-months' subscription to POPULAR RADIO *free*—merely by inducing someone else to subscribe.

Or if you secure two subscriptions, you get a *year's* subscription for yourself, free of cost.

You have only to show this copy of POPULAR RADIO to friends who you know would be interested. Demonstrate to your friends the many valuable features of the magazine. They will be glad to subscribe. Then simply send to us the $3 you receive for each subscription you take, and *your own* subscription will be entered, renewed or extended, free of charge.

Will you help to make POPULAR RADIO'S Birthday Party a success?

Simply return to us the little coupon below, with the necessary remittance to cover all subscriptions you send. We will do the rest—putting you down on the list for the free term of subscription to which you are entitled as a reward for your efforts, and entering all subscriptions you send us, to start with the May Anniversary Number.

POPULAR RADIO, Inc., Dept. 49
9 East 40th Street, New York City

I am glad to help make POPULAR RADIO'S second birthday a pleasurable one. Enclosed is $ .... covering .... new yearly subscriptions to POPULAR RADIO (at $3 each) which I have taken from friends and acquaintances. As a reward to me, you are to enter (renew or extend) my own subscription for .... months free of charge (6 months for each subscription I have sent). The names and addresses of the new subscribers are listed on a sheet of paper attached to this coupon.

MY NAME.....

MY ADDRESS.....

.....

(No extra for Canada. Foreign countries, 50 cents postage extra.)

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D. V. 2 Storage Battery
D. V. 3 Dry Cell
$6.50 Each

A Set is only as Good as its Tubes

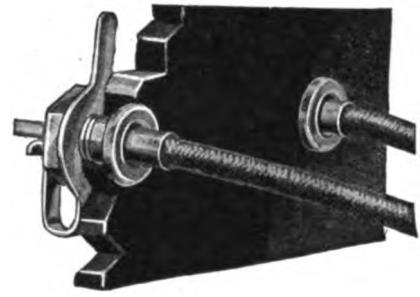
DeForest Audions are the Finest Tubes made

DeForest Audions

"Made by the Man Who Invented Broadcasting"

DeForest Radio Tel. and Tel. Co.
Dept. P. R. 8 **Jersey City, N. J.**

Improve Your Set



Union Radio Tip Jacks

(Patent Pending)

Only 25c a Pair

No more trouble with binding posts, no more noises from poor connections. Use these tip jacks for all antenna, ground and battery connections and contacts. They give you quickly made, positive connections, and improve the appearance of your set. Now being used by leading set manufacturers.

Two sizes for all mountings. STANDARD TYPE A for panels up to ¼" thick. SPECIAL TYPE B for panels, cabinet walls and partitions from ¼" to ½" thick. Will firmly grip all wires from No. 11 to No. 24 B. & S. gauge and can be reamed to hold antenna wire.

No parts to chip, lose or deteriorate. All parts heavily nickel plated.

25c a Pair in U. S. 35c in Canada.

Other Guaranteed Union Radio Parts

DIAL ADJUSTERS for minute variations in capacities of variable condensers. Price 60c.

TUBE SOCKETS of molded condensite highly polished. Phosphor Bronze contact springs. Reinforced bayonet slot prevents breakage. Accommodates all standard tubes. Price 70c.

Should your favorite Radio Store not carry Union Radio Tip Jacks and other guaranteed Parts send your order direct to us; also write for your copy of "The Union Radio Catalogue A."

Retailers and Wholesalers

Samples of our guaranteed reasonably priced "Quality Products" sent on request. Our terms and trade discounts are liberal. Write for our proposition. Also write for your copy of the Union Radio Catalog "A."

UNION RADIO CORPORATION
200 MT. PLEASANT AVENUE, NEWARK N.J.
NEW YORK OFFICE 116 WEST 32 STREET.

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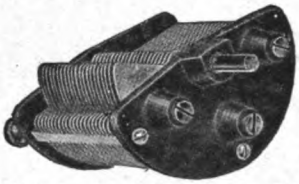
Sexton Condensers



High grade instruments made of most expensive materials and finest workmanship.
Pigtailed Connections—Genuine Bakelite End-plates—Accurate Spacing of Plates—Smooth Action.

Write for descriptive circular and name of nearest jobber

THE HARTFORD INSTRUMENT CO.
308 Pearl Street Hartford, Conn.

CRESCENT LAVITE RESISTANCES

12,000
48,000
50,000
100,000 } Ohms.

LIST **$1.50**

Used in the New Cockaday Circuit. Dealers write for discount.
CRESCENT RADIO SUPPLY CO. 1-3-5 Liberty St., Jamaica, N. Y.

YOU DON'T NEED TUBES

to hear programs from stations 400 to 1000 Miles Away. I can show you how to get them on YOUR CRYSTAL SET. Changes often cost Less Than One Dollar. Send self-addressed envelope for picture of my set.

LEON LAMBERT
540 So. Volutsia. Wichita, Kansas

ZENITH

THE EXCLUSIVE CHOICE OF DR. MAC MILLAN for his ARCTIC EXPEDITION

Zenith Radio Corporation
328 South Michigan Avenue, Chicago, Ill.

SUPER-HETERODYNE TRANSFORMERS

Write for details and prices

RIEGER-BAILEY CO. of America
820 Real Estate Trust Bldg.
Philadelphia, Pa.

Make $100 Weekly In Spare Time

Sell what the public wants—long distance radio receiving sets. Two sales weekly pays $120 profit. No big investment, no canvassing. Sharpe of Colorado made $955 in one month. Representatives wanted at once. This plan is sweeping the country—write today before your county is gone.

OZARKA, 855 Washington Blvd., CHICAGO

RUSONITE

RADIO CRYSTAL

USED ALL OVER THE WORLD
Guaranteed. Price Mounted 50c
RUSONITE CATWHISKER 14K. GOLD, 25c
Rusonite Products Corporation
15 Park Row, New York, N. Y.

NASSAU CABINETS

SOLID MAHOGANY

Assembled Rounded and Finished.		Knockdown with Screws and Hinges.	
14x7x7	$6.00	14x7x7	$2.50
21x7x7	7.50	21x7x7	3.50
26x7x7	8.50	26x7x7	4.50
36x7x7	10.00	36x7x7	5.50

All other sizes, any length, height and depth at corresponding prices. Sent C.O.D.

NASSAU CABINET CO.
20 NASSAU STREET, NEW YORK

The Copper Giant "A" Battery

A small size for 199 type tubes. **1000 hours, ¼ cent per tube per hour.** No deterioration when idle. Can also be used for WD11 and WD12 at a cost of less than ½ cent per tube per hour. Write for circular.

THE COPPER GIANT BATTERY CO., Lansdowne, Pa.

FOR BEST RECEPTION you need

The Goodman

The niftiest short wave tuner on the market. Great for present broadcasts, local and DX. Used in all parts of the world. Certificates of merit from testing laboratories. Pamphlet on request.

L. W. GOODMAN, Mfr., Drexel Hill, Pa.

LOUD SPEAKING CRYSTAL SET

Stations brought in from over 1000 miles and music heard all over the room right from your present crystal set with the STEINMETZ AMPLIFYER. Get our complete catalog.

STEINMETZ WIRELESS MFG. CO.
5703 Penn Ave., Pittsburg, Pa.

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MAX D. ORDMANN, Reg. Pat. Lawyer,
Mech. and Elect. Engineer,
Specializing in Radio
1503 Woolworth Bldg., N. Y. City Tel. Whitehall 7040-1

Insist on the new 1924 model!

"4-Way" Switch Plug

Now vastly improved —with new positive spring locking terminals which never work loose. Only $1.50 at your dealer's.

Four Way Co., Springfield, Mass.

RADIO WORLD

The Great Illustrated Weekly. All dealers. 15c copy. Yearly (52 nos.), $6. Six Months, $3. Three Months, $1.50. Full of latest technical and news developments in radio. **Special: $1.00 for trial subscription of 10 issues.** Send 15c. for big Anniversary Number.

RADIO WORLD, 1493 Broadway, New York

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HANES-ZENER CO.

1480 Broadway, Corner 42nd St., New York City

IN STOCK ALL PARTS FOR THE NEW AND IMPROVED

Cockaday Four Circuit Receiver

As described by Mr. Cockaday in January Popular Radio

Original and Genuine P-L Resistances	100,000 Ohms 80,000 Ohms 50,000 Ohms 48,000 Ohms	List Price	**$1.00**

DEALERS
Write for Our Discounts

Send for Our Complete Catalogue G and Price List

"Just Off The Press"

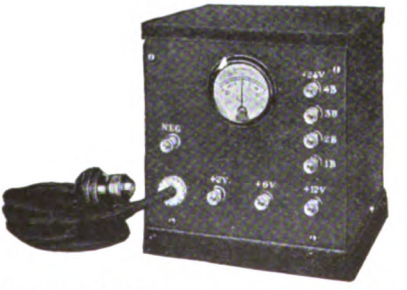
Mailed anywhere upon receipt of 2 cent stamp

KEEPS THE RADIO SET ALIVE

HANDY CHARGER

A Battery Charger that gives a quick charge economically. No Sticking Contacts. No bulbs nor Liquids. Fully enclosed — beautiful.

SIMPLEX MODEL — For 6 volt Batteries only. The Most Practical, Most Complete Battery Charger, for only **$16.00**



ULTRA MODEL — Charges Them All, Charges 2 volt, 4 volt, 6 volt, 8 volt, 10 volt, 12 volt and 1 to 4 "B" Storage Batteries, with WESTON AMMETER, **$18.00**

All prices f. o. b. St. Louis

INTERSTATE ELECTRIC COMPANY *of St. Louis, Mo.* **4015 Laclede Avenue**

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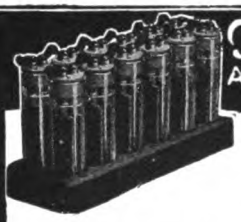

The RāBAT Junior $3.96

A Rechargeable Wet 'B' Battery. Capacity 800 Mil-Amps.
12 CELLS 24 VOLTS

Here are two acid type wet "B" radio batteries that are entirely free from internal current leakage. All elements visible through clear glass cells. RABATS have longer life with higher and more continuous voltage. Noiseless and compactly constructed—The Rabat Junior with a capacity of 800 mil-amps at $3.96 and the Rabat Senior with a capacity of 2800 mil-amps at $9.60 represent more actual battery value at a lower cost. More economical to buy—more economical to maintain. Easily recharged from ordinary house current. If your dealer cannot supply you send direct.

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A Rechargeable Wet 'B' Battery. Capacity 2800 Mil-Amps. 48 VOLTS $17.88

Announcement *to the* Radio Trade

POPULAR RADIO has a message of interest to radio jobbers and dealers who are eager to increase their sales and their profits.

We have recently published a large 100-page book: "How to Build Your Radio Receiver," edited by Kendall Banning and L. M. Cockaday. This book is described on pages 110 and 111 of this issue of POPULAR RADIO.

Also, we have published two sets of Blueprints covering all constructional details for the "Improved" Cockaday 4-Circuit Tuner and for the Non-Regenerative Tuned Radio-Frequency (Neutrodyne) Receiver. (These Blueprints are described on page 68 of this issue.)

Although this book and these Blueprints have been published primarily to supply the needs of POPULAR RADIO readers, we are willing that recognized radio jobbers and dealers be furnished a limited supply of these books and Blueprints for sale to their customers.

By carrying in your stock a reasonable supply of these books and Blueprints, you will render a valuable service to your radio customers.

For full information regarding prices and terms, simply mail the attached coupon to POPULAR RADIO, Department 47, 9 East 40th Street, New York City.

POPULAR RADIO, Inc., Dept. 47
9 East 40th Street, New York City

Please send me full information regarding your prices to the radio trade on POPULAR RADIO's handbook, "How to Build Your Radio Receiver," and on your Blueprints. I enclose my business letterhead pinned to this coupon.

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RED-HEAD RADIO RECEIVERS

NOW READY

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Still Time to Get This Big Book FREE

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THE first edition of POPULAR RADIO's new 100-page handbook, edited by Kendall Banning and Laurence M. Cockaday, is fast becoming exhausted. It can be ***given away free,*** for only a limited time longer.

So great has been the demand for this new handbook, "How to Build Your Radio Receiver," since its publication was first announced, that now after only 90 days it is necessary to plan for a second printing.

Therefore it is very doubtful how long this most liberal introductory offer can be held open.

This book is the most comprehensive and valuable contribution of its kind ever published for the radio enthusiast who, ***with or without previous technical knowledge or training,*** wishes to construct a radio receiving set of his own that will meet his every requirement.

"How to Build Your Radio Receiver" gives complete specifications for the construction of *seven* separate and distinct receiving sets—covering the most remarkable range and variety of circuits, from the most modern simple crystal set to the famous Super-heterodyne.

All working details are given—the list of parts required and their approximate cost; complete hook-ups and circuit diagrams and *how to read them;* illustrations making all points clear, and simple instructions on how to assemble, mount, wire and operate each set.

Scores of Helpful Hints

In this new book edited by Mr. Banning and Mr. Cockaday, you will also find scores of valuable suggestions about aerials, how to select your parts, how to install your set, tips on tuning and how to learn the code.

In all, a book you will not want to be without—one that will be worth many dollars to you. Yet, if you act at once, it will cost you not a penny. We will send you a copy of this valuable handbook absolutely free with a year's subscription to POPULAR RADIO.

The Coupon printed at the bottom of the opposite page provides a convenient means for you to secure this big cloth-bound handbook free. But you must act quickly!

100 PAGES Size 7¾ x 11¼ inches

Edited by
Kendall Banning and L. M. Cockaday

—How to build a Crystal Set.

—How to build the Haynes Single Tube Receiver.

—How to build a Two-Stage Audio-Frequency Amplifier.

—How to build the Original Cockaday 4-Circuit Tuner.

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—How to build the Regenerative Super-heterodyne Receiver.

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9 East 40th Street :: New York City

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"'How to Build Your Radio Receiver,' is one of the most complete books of its kind I have ever seen. I wish that all the books that come to my notice were as worthy of commendation as this one."
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New York Evening World.

"Mr. Banning and Mr. Cockaday have compiled a book which deserves to rank high in the estimation of amateur set builders. The typography is excellent, the diagrams clear and easily read, and the whole manner of presentation far superior to anything that has thus far been attempted by a radio publisher."
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Formerly Editor of "Scientific American" and "Popular Science Monthly."

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New York Evening Journal.

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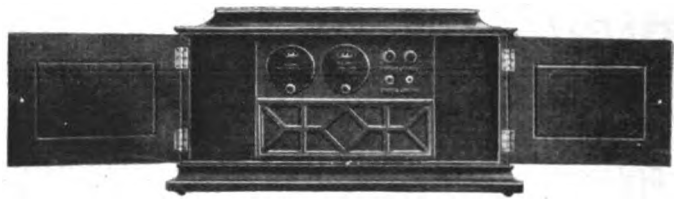

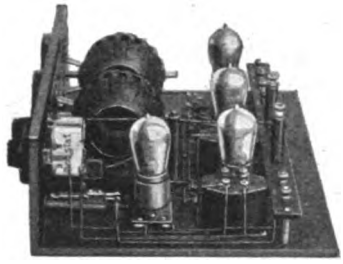

Amrad Radio Unit, removed from Console Cabinet, to show Bradleystat and Bradleyleak mounted in front of detector tube

Amrad Adopts Both Bradleystat and Bradleyleak!

The Amrad Jewel—Italian Renaissance Period Art Model Is Now Equipped With Ultra-Fine Tuning Control

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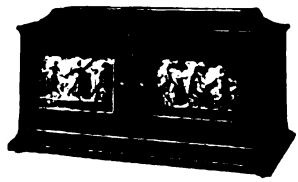
The Console models, with self-contained loud speaker, battery compartment, and highly perfected tuner, are made more selective with the ultra-fine filament and grid control, so essential for long range reception.



YOUR radio receiving set will afford new possibilities and new thrills if equipped with Bradleystats and Bradleyleaks. Many radio dealers replace the wire rheostats of ready-built sets with Bradleystats, and they invariably recommend them to set builders who seek the best in radio.

The Bradleyleak has the endorsement of Amrad, Flewelling, Kennedy, Crosley, Clarkson, Cockaday, and other radio engineers. It is pronounced "the perfect grid leak" by all users.

Get the benefit of the graphite disc design by avoiding all substitutes. Carbon or metallic powder was abandoned, years ago, as impractical and unreliable. Insist that your dealer supply you with the genuine Bradleystat and Bradleyleak.

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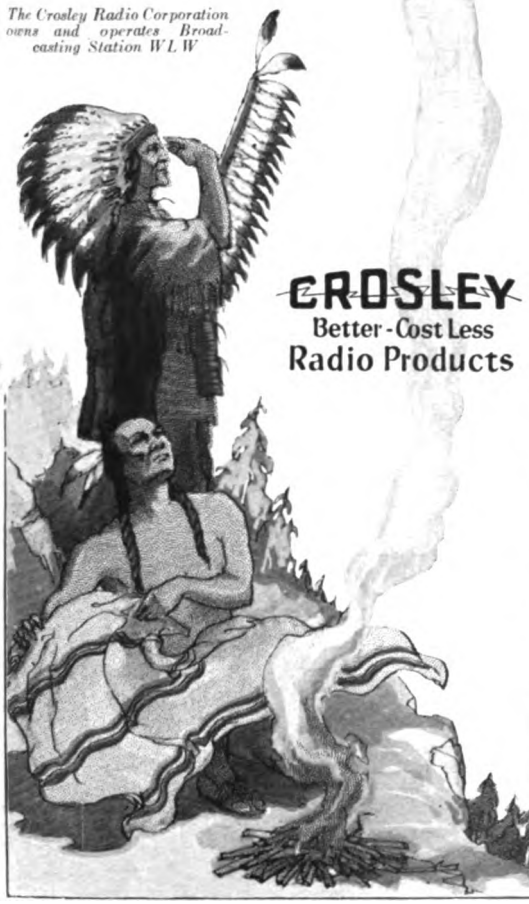

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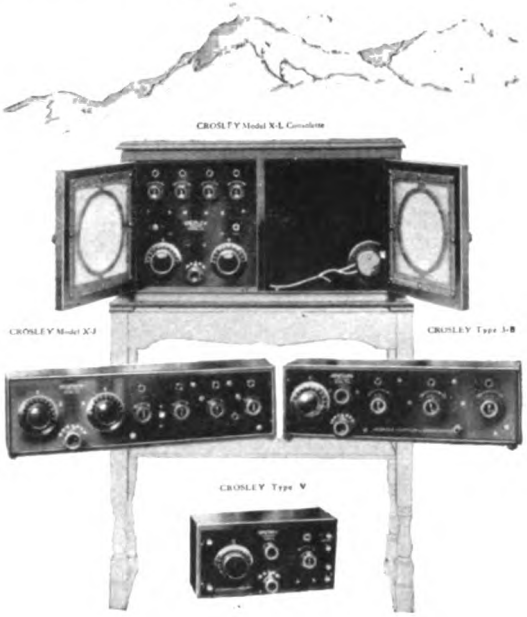

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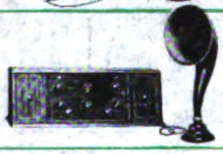
	Same without Loudspeaker.	$65			
	**Radiola Regenoflex** with four WD-11 Radiotrons,* and Radiola Loudspeaker.	$206	Loudspeaker operation up to 2000 miles under favorable conditions.	Outdoor or indoor antenna.	Extraordinary selectivity. Non-radiating.
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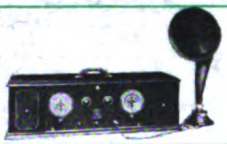	**Radiola Super-Heterodyne** with six UV-199 Radiotrons* and Radiola Loudspeaker.	$286	Loudspeaker operation up to 2000 miles with internal loop. With external loop up to 3000 miles under favorable conditions.	No antenna. (Concealed small loop built into set.)	Super-selectivity. Non-radiating.
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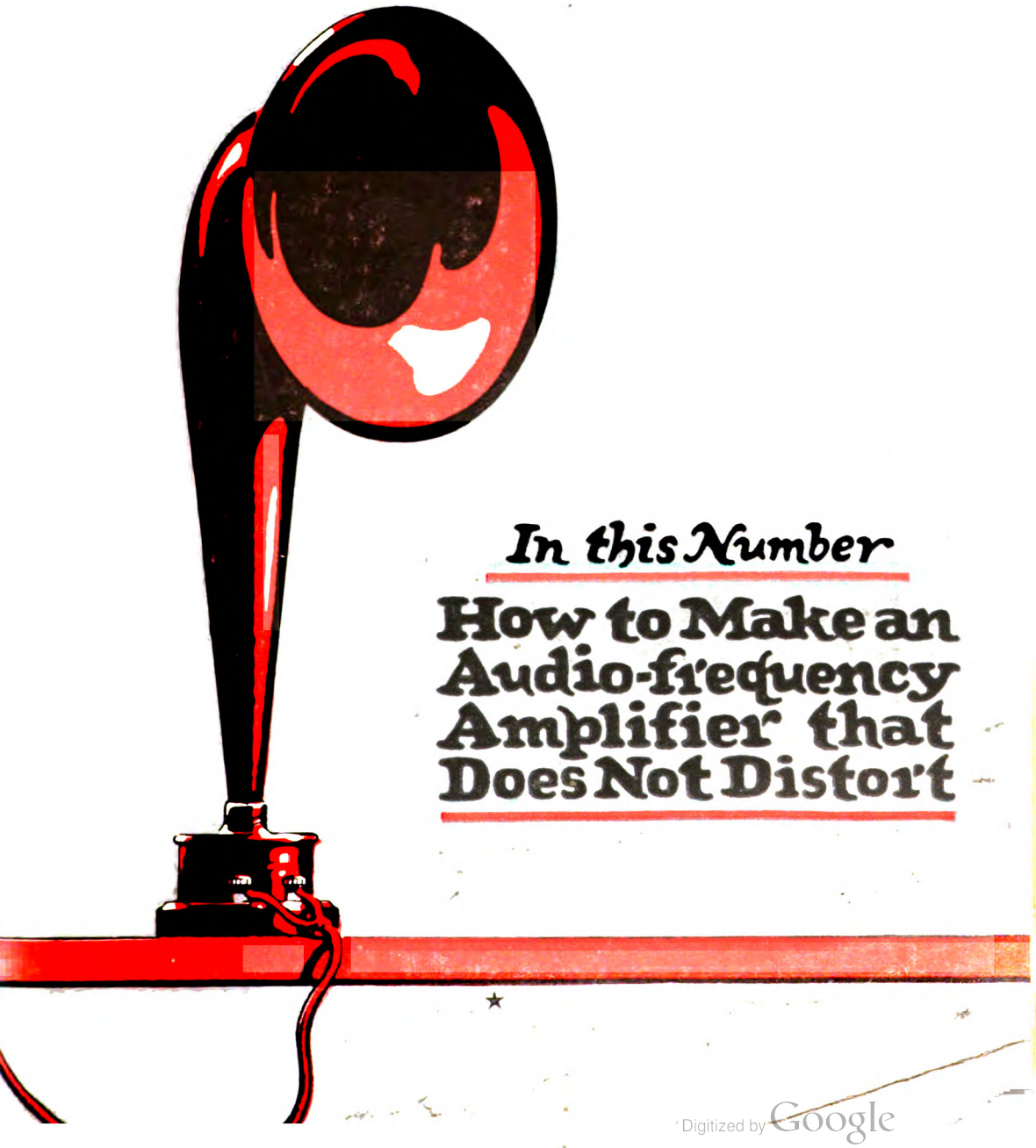
MAY 1924



In this Number

How to Make an Audio-frequency Amplifier that Does Not Distort

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The name to know in Radio

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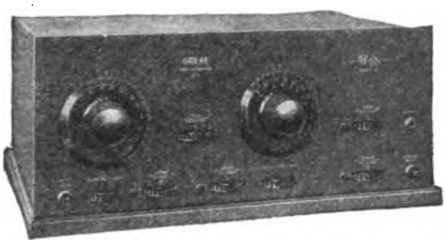

Type CR-12. A 4-tube Receiver combining Regeneration and Tuned R.F. $175.00
(*Accessories extra*)

WHETHER the evening's feature be the broadcasting of the World's Heavyweight Championship or a Sunday Night Concert, you will anticipate it with keen pleasure and confidence when you tune in with your

GREBE Broadcast Receiver

Made in two easily operated types, in which every detail of craftsmanship is an assurance of trustworthy performance.

Each Instrument is the result of more than ten years of radio manufacturing experience.

Ask your Dealer or write us for literature

A. H. GREBE & CO., Inc.
Van Wyck Blvd., Richmond Hill, N.Y.
Western Branch: 451 East 3rd Street, Los Angeles, Cal.

Licensed Under Armstrong U.S. Pat. No. 1,113,149

Type CR-14. A 3-tube dry cell Regenerative Receiver $110.00
(*Accessories extra*)

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PAGES WITH THE EDITOR

WITH this number POPULAR RADIO celebrates its Second Anniversary—with a bigger and (we believe) better magazine than has ever been issued before.

* * *

Two years ago this month, POPULAR RADIO started out as a modest little publication of only 72 pages. This present number that you have in your hands now contains 220 pages—a growth of over 300 percent!

* * *

Two years ago the well-known amateur, William Andrew Mackay (2AQB) called personally at our office and paid in cash the first subscription to be entered in our books. Today that list has grown to 34,000—the largest subscription list of any radio magazine in the country.

* * *

DURING the last six months of 1923 (according to the figures of the Audit Bureau of Circulation) the total net sales of this magazine showed the extraordinary gain of 92 percent—an increase that (so far as we know) marks POPULAR RADIO as "the fastest growing radio magazine in the world."

* * *

WHY POPULAR RADIO is leading all other magazines in circulation gains may be explained in two ways.

First; because it is giving the radio amateurs and broadcast listeners the practical, helpful and interesting articles that they most want to read;

Second; because it includes among its contributors the foremost scientists, inventors, writers and radio experts of the world.

* * *

HERE, for example, is a partial list of some of the world-famous authorities who contribute to POPULAR RADIO—a list of such extraordinary distinction as to prompt one reader to refer to POPULAR RADIO, not only as "the leading magazine in the radio field, but one of the most distinguished class magazines of our time."

Sir Oliver Lodge (British), Dr. Lee De Forest, Dr. Elihu Thomson, Dr. Irving Langmuir, Senator Guglielmo Marconi (Italian), John Hays Hammond, Jr., Nikola Tesla (Serbian), Hudson Maxim, Prof. J. H. Morecroft, Prof. James A. Fleming (British), Dr. Charles P. Steinmetz, Dr. Ernest Fox Nichols, M. Edouard Belin (French), Laurence M. Cockaday, Major-General George O. Squier, John V. L. Hogan, Sir Joseph J. Thomson (British), Paul Godley, Hiram Percy Maxim, Raymond Francis Yates, Jesse Lynch Williams, Will Irwin, Waldemar Kaempffert, Ellis Parker Butler, William G. Shepherd, Gerald Stanley Lee, Fred C. Kelly, Gelett Burgess, Dr. Austin Bailey, Powel Crossley, Jr., Prof. Gordon D. Robinson, Lt. Commander Fitzhugh Green, George Creel, Homer Croy, Howard Brubaker, Harry Houdini, Commander S. C. Hooper, Dr. G. W. Pickard, Prof. Reginald A. Fessenden, Henry D. Hubbard, Harold P. Donle, J. C. Gorman, Dr. Clayton H. Sharp, James H. Collins, Dr. Hereward Carrington, Leroy Scott, Mrs. Christine Frederick, Armstrong Perry, Dr. E. E. Slosson, Forrest Crissey, Percy Mackaye, Morris S. Strock, E. L. Hall, Dr. Emil Wiechert (German), Capt. H. J. Round (British), Dr. Louis Cohen, Gen. Gustave Ferrié (French), Prof. A. M. Low (British), Marlen E. Pew, Orson Lowell, Robert C. Benchley, George H. Doran, Watson Davis, Dr. Henry Smith Williams, Major General J. G. Harbord, Robert G. Skerrett, William J. Burns, Clare Briggs, Hon. John J. Tigert, T. Commerford Martin, Edward R. Hewitt, Don Herold, Dr. Edwin G. Northrop, Dr. Willis R. Whitney, Dr. E. E. Free, Capt. Leon Deloy (French), C. Francis Jenkins, Commandant René Mesny (French).

* * *

WITHIN the past seven months POPULAR RADIO has gained 300 percent in advertising—the greatest increase ever achieved by a magazine within an equal period. Now, advertisers give increasing patronage to a particular magazine for just one reason—because that magazine pays advertisers best.

* * *

AND this gain of 300 percent is of particular significance because, within this very period, POPULAR RADIO has excluded from its pages a large volume of advertising which it believed to be contrary to the best interest of the radio fan and of the radio industry for the leading radio magazine to continue to carry—general, or non-radio, advertising, cut-rate advertising, and the advertising by fly-by-night concerns.

* * *

OUR experiment of reversing the old, standard left-to-right presentation of radio circuit diagrams is meeting with a good deal more than the casual attention of the radio fans. Promptly following the announcement (in our March issue) of our intention to test out the scheme in our April number, the Editor began to receive letters for and against the change; so far he has received five letters in favor of the new right-to-left arrangement to one in favor of the old left-to-right arrangement. Write the Editor and tell which *you* think is better! (On page 476 of this issue you will find a right-to-left circuit diagram.)

* * *

THE first letter to reach the Editor came from the engineering concern of Willis L. Adams of Niagara Falls, N. Y.; it expresses disapproval of the proposed change as follows:

"We cannot see any reason why a radio diagram should read from the right instead of from the left. English speaking people as well as most others read from the left to the right and we cannot see any reason why we should become Orientals and learn to read from the right to the left. The fact that a radio set is

(*Continued on page 6*)

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Dubilier Duratran

reduced from $5.00 to

$4

INCREASED production facilities have lowered the manufacturing costs of the Dubilier Duratran Radio-Frequency Transformer.

And the public receives the benefit in a big price reduction.

No Missing Wavelengths With the Duratran

Think what this means.

The Dubilier Duratran is designed to bring in all the broadcasting stations—not just one or two. And it does this with an amplification factor of over twenty for all broadcasting wavelengths.

Every Duratran is carefully tested for stability, amplification and wavelength range before it leaves the factory.

Write for Free Blueprints of R. F. Hook-ups

Ask your dealer for free blueprints of Duratran radio-frequency hook-ups. If he has none, write to us for them and give us his name.

Dubilier Condenser and Radio Corporation
40-50 West Fourth Street, New York

DUBILIER DEVICES

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(*Continued from page 4*)

reversed while the wiring is being done does not complicate matters at all, as the mind subconsciously reverses the diagram."

* * *

BUT the next few letters that came in were all in favor of the proposed change. Here are quotations from the first three of them:

"I have long been of the opinion that the reverse order to that in which radio diagrams are given would be more logical—so much so that I usually make such a diagram for any particular hook-up that I wish to keep."

—WILLIAM J. MYATT, *Philadelphia, Pa.*

* * *

"I AM inclined to believe that the change will be welcomed by the bulk of your readers. Personally, a reversed diagram looks funny to me because I've looked at so many with the input at the left, but in actual practice I find little difficulty reversing the plan in my mind; this is undoubtedly due to the fact that my mind has been trained to reverse it. A reversed plan would not be as confusing to me as the old-style plan is to a person constructing his first set; therefore, I am in favor of your idea."

—CHARLES G. KITTNER, *Clifton, N. J.*

* * *

IN one of the important French radio magazines for January, *La T. S. F. Moderne*, there is a complimentary article by A. Marie on how to build the Cockaday one-tube receiver.

"You will be astonished by the selectivity of this apparatus as well as by its great sensitivity," the author writes. "The results that you will obtain will repay you, I am sure, for the trouble of reading this article and of building the Cockaday apparatus. In particular, although we were using an antenna placed only 400 meters from Station PTT, which is less than the wavelength of this station, we have been able to receive London distinctly."

* * *

STEADILY the circuits developed by and published in POPULAR RADIO are spreading over the world.

* * *

ONE of the most interesting of the "human documents" that have found the way to the Editor's desk during the past month comes from Guatemala in Central America—a tiny republic that is so remote that few of the inhabitants have ever heard of radio and where "no radio apparatus is for sale."

* * *

THIS particular document comes in the form of a letter from M. Turton, who, despite his isolation from the radio world, has all the earmarks of the dyed-in-the-wool fan, with all of the real fan's ingenuity and enterprise. He recently wrote to station KFKX in Hastings, Nebraska; his letter tells his story:

* * *

"I NEVER saw or heard a radio receiving set until November 15, 1923. On that date I had the good luck to get hold of the October number of POPULAR RADIO. I read a few pages in it and became so interested in it that I decided to build a triple-honeycomb-coil set as described in that issue.* The article explained how to make the coils but not how to make the variable condensers. This was a poser, but not for long; I looked through the advertising columns which showed pictures of condensers, these were sufficient to go by. I built a 43-plate and a 13-plate condenser.

* * *

"THE next item was where I was going to get a vacuum tube. Then I thought of the ships that come into Barries, which is the Guatemalan port. Here I was able to buy a UV-201 tube. I put up an antenna 25 feet high at one end and 18 feet at the other end, and 50 feet in length. Then I was ready to go to work—but I am sorry to say that I could not hear anything at all. I played with the thing a week and after making some alterations I listened in on December 20th. Great was my surprise to hear a piano playing! The announcement I could not get well at first, because I did not know how to tune in, but last night I was able to recognize the announcers' voices of station WLW in Cincinnati, Ohio, and KFKX in Nebraska."

"POPULAR RADIO AHEAD OF THE RADIO INDUSTRY"

DURING *its first two years of existence* POPULAR RADIO *has made the wonderful strides necessary to keep it abreast—ahead of—the progress of the industry. The editors and managers are to be congratulated, and basing expectation on past performances, there is no reason to expect but that* POPULAR RADIO *will still be well in the lead on its next birthday."*

—PAUL F. GODLEY.

* "How to Make a Simple Honeycomb Receiver," by S. Gordon Taylor.

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"THE AIR IS FULL OF THINGS YOU SHOULDN T MISS"

Get ready *now* for summer radio

A GREAT radio summer is at hand. To enjoy summer radio at its best, equip your receiver with the best batteries you can get. Put in new Eveready Radio "B" Batteries and see what wonderful, long-lived service they will give.

Made especially for radio use, Eveready "B" Batteries will operate the loud speaker at maximum volume for long or short periods, depending on how rapidly the current is taken out of them. Packed full of pep and punch and go, Eveready "B" Batteries pour out their power the moment you turn on the tubes.

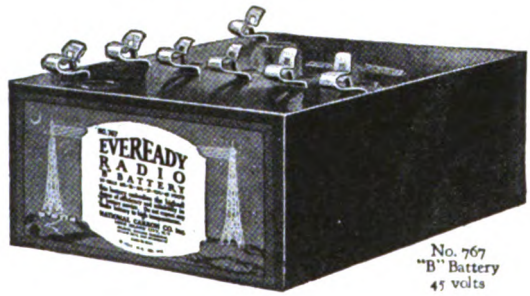
Eveready "B" No. 767 is the standard amplifier "B" Battery, and gives 45 powerful, dependable, zippy volts. Five sturdy Fahnestock Clips make this big "B" Battery available for detector tube use as well—varying the voltage from 16½ to 22½ as required.

Insist on Eveready "B" Batteries, remembering that they are the product of thirty years of experience and know-how in battery making. For maximum battery economy and service buy Eveready Radio Batteries—they last longer.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, INC.
Headquarters for Radio Battery Information
New York San Francisco

Canadian National Carbon Co., Limited
Factory and Offices: Toronto, Ontario



No. 767
"B" Battery
45 volts

Storage "A" Battery

No. 766 "B" Battery 22½ volts

No. 7111 Dry Cell "A" Battery

No. 764 "B" Battery

No. 771 "C" Battery

EVEREADY
Radio Batteries
—they last longer

Informative and money-saving booklets on radio batteries sent free on request. If you have any questions regarding radio batteries, write to G. C. Furness, Manager, Radio Division, National Carbon Co., Inc., 128 Thompson Avenue, Long Island City, N. Y.

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(Continued from page 6)

A JOURNALIST'S VIEWS ON THE EFFECT OF RADIO ON JOURNALISM

MARLEN PEW, the author of "What Is Radio Doing to Our Newspapers?" on page 423 of this issue, writes from the point of view of the thoroughly experienced and essentially practical-minded journalist. Beginning as a reporter on the Cleveland (Ohio) *Press* back in 1897, he has had extensive training in the newspaper world; during the World War he came prominently into the public eye as the head of the News Bureau of the War Department, and later as the general manager of the International News Service. He is now editor and publisher of *The Editor and Publisher.*

* * *

WHEN POPULAR RADIO announced its policy of refusing advertising from fly-by-night manufacturers and dealers of radio apparatus, it did so with the purpose not only of maintaining the integrity of its advertising pages but also with the purpose of protecting both its readers and its advertisers from irresponsible business concerns. This policy is costing this magazine several pages of advertising a month. We knew that it would.

* * *

As evidence of the sincerity with which this policy is maintained, we are publishing here some correspondence that tells a dramatic little story that is well worth recording. The episode begins with the following letter written on the stationery of a radio club:

* * *

"WE are a strong group of radio fans very much interested in the manufacture of vacuum tubes. We own and operate a small factory where we have conducted some valuable experiments resulting in a tube which we believe the equal if not the superior of the RCA 201-A. We are aware, however, that owing to patent difficulties, we cannot for the present appear under our own name, nor can we give the actual location of the factory as we may be forced to move our equipment at a moment's notice in order to avoid an injunction. We are, however, ready to start an advertising campaign on this tube and have appropriated for this purpose about $2,000 to cover one year's advertising, believing that at the end of that time the patent situation will have clarified so that we can come out in the open. We would appreciate your writing us, not only as to rates, but as to whether we can depend upon you to hold our actual address and location in confidence and permit us to use a mailing address only, which will be on Fifth Avenue in New York City. Upon receipt of a favorable reply, we will send our representative to discuss the matter with you."

* * *

THE second chapter opens with a personal call at the office of POPULAR RADIO. The result of that call is recorded in the following letter from the same source:

* * *

"OUR representative left with you a sample of the tubes which we are now manufacturing. We shall be interested in a report of the same at your early convenience. We wish to confirm conversation with him in regard to our stamping these tubes and to assure you that we will positively never stamp our tubes 'Radiotron' or any name remotely resembling it. Furthermore, our advertisement will carry an absolute guarantee covered by a deposit in cash, preferably with your management, to insure refund on any tubes purchased from us, which do not give absolute satisfaction. Again we wish to emphasize the fact that all we would ask of you is to consider the location of our factory and the names of the officers of the company in strict confidence. We wish to state, furthermore, very frankly, that we are aware of the facts that our tubes infringe on certain patents and that they infringe in exactly the same way as do all makes of independent tubes now on the market. In fact a notice of infringement has been received at our present mailing address, but we have paid no attention to it.

* * *

"WE are prepared to move our factory over night at a moment's notice. In fact, all our machinery is not permanently attached to the floor, but is mounted on platforms which can be moved in short order. Two months ago, we were tipped off to the effect that an operative of the RCA had obtained access to our plant, and we were obliged to move the same in the night to our present location. It is our intention to operate under quite a different name from that of the factory. Furthermore, in common with most independent manufacturers of tubes, we do not intend to register our firm name in the County Clerk's office at present. In placing these facts frankly and freely before you, we shall look confidently for equal frankness on your part, and the acceptance of our advertisement, or, failing that, good reasons why you cannot do this."

(Continued on page 10)

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For Those Who Demand the Best

The Thompson MAGNAPHONE

Reg. U.S. Pat. Office

Supreme in Tone and Volume

Price $35.00
At Dealers Everywhere

Radio At Its Best

A radio reproducer specially designed — and proved by the experience of hundreds of users — to bring out the best that any receiving set can afford, the THOMPSON MAGNAPHONE is free from the shortcomings that limit the possibilities of loud speakers of the ordinary or "telephone receiver" type. It enables you to enjoy radio at its best — it multiples the "pleasure possibilities" of any radio receiver.

The Thompson NEUTRODYNE RADIO

Licensed under Hazeltine patent No. 1,450,080 and pending application Ser. No. 433,729. Other patents pending.

Price $150.00
Without Tubes or Batteries

The range, the selectivity, the clearness of reproduction, the simplicity of operation, for which the neutrodyne stands in the world of radio, are exemplified in highest degree in this THOMPSON NEUTRODYNE—the product of 14 years of high-quality radio manufacturing experience. Carefully balanced, thoroughly tested, correct in design, refined in every construction detail, the THOMPSON NEUTRODYNE reveals radio at its best — whether in the hands of the experienced radio enthusiast or in those of the newest beginner. Your dealer can give you a demonstration — ask him.

R. E. THOMPSON MANUFACTURING CO.

Sales Office: 150 Nassau St., New York **Factory: Jersey City, N. J.**

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(Continued from page 8)

As a matter of mere business routine this offer of a $2,000 contract was rejected by our advertising manager, who wrote: "I am sorry to have to advise that our policy will not permit of our handling your advertising."

* * *

THE concluding chapter comes in the form of a letter written on the stationery of the West Englewood, N. J., Radio Club, signed by its secretary, Mr. James W. McConnell. Here it is:

* * *

"YOU have been very frank, and we are, therefore, going to be very frank with you. We thank you, therefore, for refusing this advertisement. It is exactly what we had expected from a publication of the standing such as yours. This may seem strange to you, but we mean every word. Furthermore, we wish to thank you for the article on Page 4 of your magazine for February, wherein your editor lays down his policy. We were particularly impressed by the statement of your intention to protect your advertisers as well as your readers against the unfair competition of fly-by-nights.

* * *

"JUST by way of test we purposely submitted to you a most tempting advertisement covering $2,000 for the year and drew an exact picture of a fly-by-night, to see whether you would rise to the bait. Thank heaven you did not, and we want to commend you for it! Henceforth 'the magazine with the silver cover' is going to be the one we shall buy and whose advertisers we shall endeavor to patronize."

* * *

THUS it is again demonstrated that inclusion in the advertising pages of POPULAR RADIO insures about the same standard of merit as the mark *"Sterling"* on silver!

* * *

"OUR little girl, Ellen, aged six," writes Mr. W. G. Beasley, a reader, of Carthage, Missouri, "saw a lake steamer for the first time and was particularly concerned with the large, funnel-like ventilators. 'Look,' she exclaimed, 'at all the ship's loudspeakers!' "

* * *

THE launching of a new book is always a matter of some concern to the publishers—especially if the book happens to be the first one. That is why the Editor awaited with special interest the first comments concerning the new volume, *How to Build Your Radio Receiver*, which is No. 1 of the proposed series of POPULAR RADIO handbooks.

* * *

THE first letters of comment reached us promptly following the mailing of the books. For the benefit of those readers who have not yet obtained the volume (which for a limited period is being presented free of charge with every $3.00 a year subscription to POPULAR RADIO), we are printing here the estimates of it that came in the first three letters to reach the Editor's desk:

"YOU have certainly compiled a book which deserves to rank high in the estimation of amateur set builders. The typography is excellent, the diagrams clear and easily read, and the whole manner of presentation far superior to anything that has thus far been attempted by a radio publisher. It requires no great prophetic gift to foretell the splendid reception by the radio public of this volume."
—WALDEMAR KAEMPFFERT, *author and scientist.*

* * *

"How to Build Your Radio Receiver is one of the most complete books of its kind that I have ever seen. I feel, after running through it, that you have struck a note that will be very popular with the beginner. I wish that all the books that come to me were as worthy of commendation and space as this one."
—ROBERT S. WOOD, *Radio Editor,*
"New York Evening World."

* * *

"WHEN I renewed my subscription to POPULAR RADIO last month I knew I would get my money's worth in the magazine, but I little realized what a fine book I was to receive until my copy of *How to Build Your Radio Receiver* arrived. It proves to me again that POPULAR RADIO never does things by halves!"
—ARTHUR R. LEACH, *Groton, N. Y.*

* * *

THAT POPULAR RADIO is being used more and more as a text-book in our schools and colleges is evidenced by the rapidly increasing number of subscriptions that are coming in from the educational authorities throughout the country. Educational authorities usually have pitifully small appropriations, and their purchases are necessarily made with great discretion; it is particularly gratifying, therefore, to record a recent bulk order of forty-four subscriptions from the Board of Education of New York.

* * *

YOUR courageous stand (in Pages with the Editor) for the protection of your readers should make you in truth the POPULAR RADIO magazine. Would that some other radio magazines had some of your courage!
—F. H. GEER, *Columbus, Nebraska.*

* * *

WITH the next issue POPULAR RADIO begins a series of articles that will be of particular value to the radio fan during the summer months—articles that tell him how to use his set in camp, on his motor car, on his boat and on hikes, as well as how to overcome many of the difficulties in getting good reception during the hot weather period.

Kendall Banning

Editor, POPULAR RADIO

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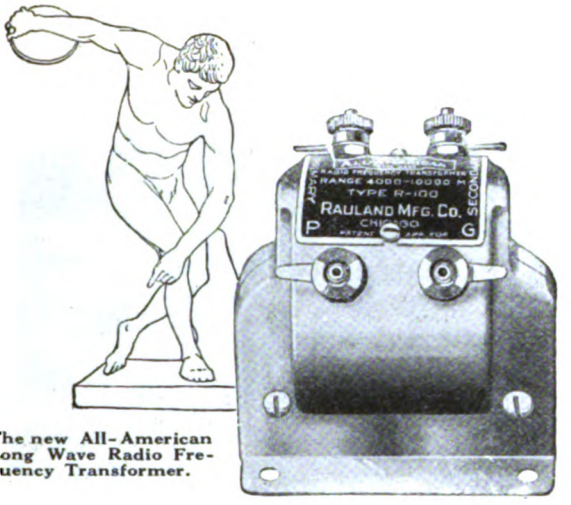

The new All-American Long Wave Radio Frequency Transformer.

The MASTERPIECE
of Amplification

Again All-American steps to the fore, this time with a long wave radio frequency transformer that has already taken two continents by storm.

Placed on the market only after every conceivable test had been given in an endeavor to find even a single flaw, it has proved itself "the masterpiece" of all transformers suitable for Super Heterodyne, Ultradyne and all straight radio frequency and reflex circuits.

It is for wave lengths 4,000 to 20,000 meters (75 to 15 K.C.). Among its advantages are: windings of extremely low capacitance, properly treated and impregnated; a handsome nickel-plated shell of the same shape and size as All-American Audio Frequency Transformers —to insure ease of assembly and neatness; and the fact it is shielded to prevent interstage coupling or reaction.

Yet the price—in conformity with the All-American policy of building only the best but building in great quantity to moderate the cost—*is but $6.*

A notable addition to the All-American family of audio and radio frequency and power amplifying transformers—the most popular, most widely used transformers in the world!

All the better dealers sell the All-American.

RAULAND MFG. CO. 2650 Coyne St., CHICAGO

SPECIAL OFFER!
Diagram-circular on power amplification and All-American Book of 22 Tested Hook-ups sent for 4c in stamps.

ALL-AMERICAN
AMPLIFYING TRANSFORMERS
Largest Selling Transformers in the World

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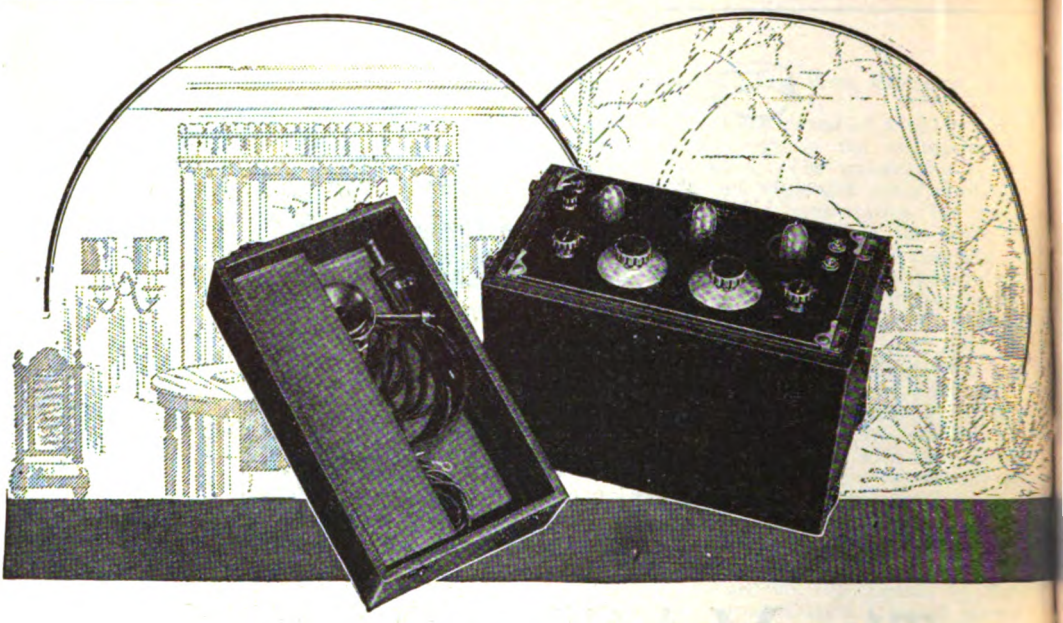

For City Homes and Summer Cottages

MODEL III

Carry it Like a Traveling Bag

A MARVEL of compactness—no larger than a traveling bag. The sturdy cabinet is covered with a grain-seal finished Fabrikoid that makes it an attractive piece of home furniture as well as a practical outdoor set.

Each station has its own dial setting—which never changes, regardless of where you are located or what kind of antenna is used. This is particularly desirable to the summer vacationist, cottager, camper or tourist—as the dial setting outdoors, with a temporary antenna, is the same for any given station as it is in your own living room.

New! The famous Kennedy built as a home radio receiver, tha is instantly convertible into a portable unit, no larger than traveling bag.

Model III is essentially the same as the latest Kennedy Receiver but is housed in a three-compartment case specially designed fo portability. It has the same purity of tone—the same naturalnes and vividness of reproduction—the same ease of tuning. By turn ing one single dial, the best broadcasting entertainment is liter ally at your finger-tips.

The circuit used is an exclusive development of Kennedy Engineers—fundamentally sound and correct. It does not radiate or throw out the squeals and whistles that are the cause of present active agitation against radiating receivers.

Price, without accessories, $101.50. ($104 00 west of Rockies.) Wit Kennedy 3000-ohm phones and plug, $111.50. ($114.00 west of Rockies.

Ask any Kennedy dealer to demonstrate this new Model III—he wi gladly install it in your home so you can judge its remarkable performance

All Kennedy Receivers are licensed under Armstrong U. S. Patent No. 1,113,149

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS

KENNEDY

The Royalty K *of Radio*

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Keystone View Co.

POPULAR RADIO Gets a Birthday Letter from Dr. Lee De Forest

I am sure no one connected with the radio art or industry can fail to recognize the debt we all owe to Popular Radio during the first two years of its existence. No agency has done more to popularize and dignify the new art, to arouse widespread interest in its merits, and abiding faith in its future, than has this magazine.

I am gratified to join with its host of friends and well-wishers on the occasion of its second birthday, in predicting for Popular Radio new usefulness and enlarged success.

Very sincerely,

Lee de Forest

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Morris Rosenfeld

Radio-operated Code Machines in a Modern News Room Are Capable of Transmitting and Receiving 800 Words a Minute

One New York daily at present sends at the rate of 48,000 words an hour to a Chicago daily by means of the Finch high-speed relay apparatus; the transmission of news pictures by radio is already an accomplished fact and will eventually become common practice. The eight code machines shown above, at present operated by wire by the Associated Press, are part of the battery of 110 that are in present use by that news agency for disseminating news to the press.

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Popular Radio

VOLUME V MAY, 1924 NUMBER 5

What Is Radio Doing to Our Newspapers?

Not since the introduction of the telegraph has any invention so profoundly affected—actually and potentially—the methods of collecting and disseminating news, or given the world such an entirely new conception of reporting. What these significant changes portend is told here by one of the best known and most successful of American newspaper men—

MARLEN E. PEW

THE insatiable appetite of the American people for news demands a practical application of radio in the wide and rich field of daily journalism. News distribution is a natural broadcasting process.

Radio in its present development is essentially a broadcasting device. The next great step in the amazing progress of domestic radio communication will be, in my belief, in the direction of news service, with ultimate revolutionary and highly beneficent effects.

However trite, it is necessary to say that news, as the basis of public opinion, is the foundation rock of popular government and, therefore, the controlling social force. Only those who have catered to the public through newspapers can estimate—and then only feebly—the craving of the average American for news concerning current events. The hands of our hundred millions eagerly reach out once, twice or thrice every day of every year for a news ration. The free flow of plain and garnished fact rushes ever on and on with the irresistibility of a Niagara; as definitely a part of every man's life as the clock, meals and bedtime.

Successful publishers are those who have in some measure caught the spirit of the people to learn quickly the truth concerning important events. The

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American press is today the best organized, freest and most enterprising engine of publicity in the world.

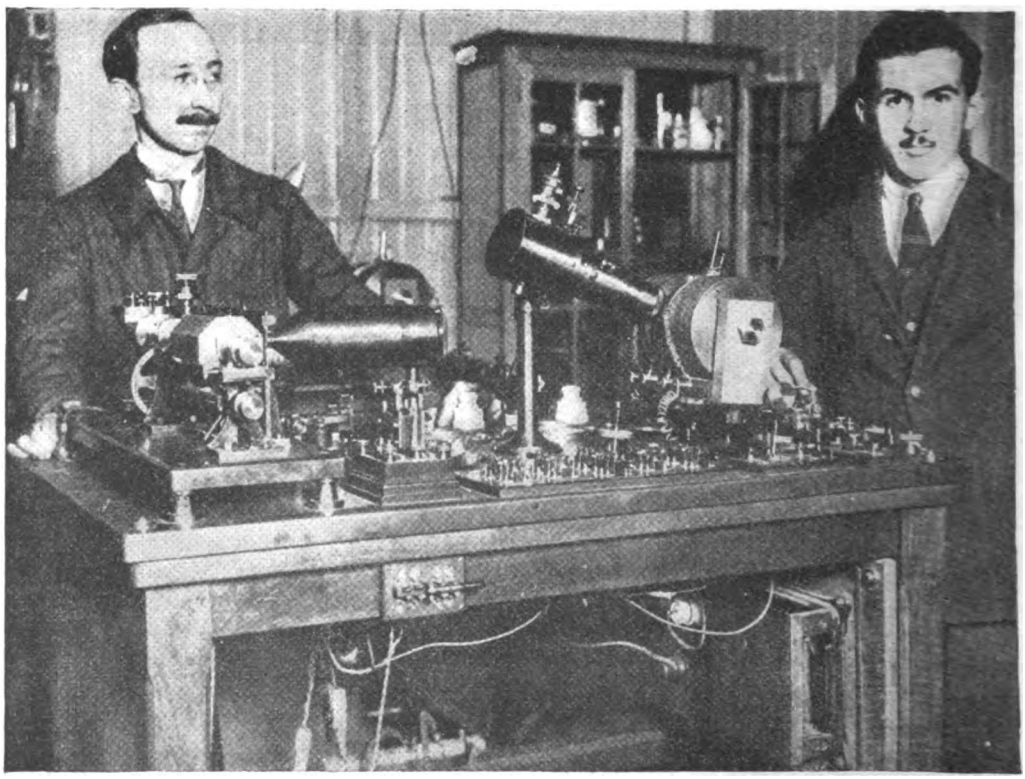
The huge dailies of the cities have grown so fat and complete with news, features and advertising as to be burdensome to read.

The modern newspaper is geared to such rapid collection of the news, printing and distribution of papers that the result of the Kentucky Derby, the death of a President, the price of corn at Chicago, the capture of a Chinese bandit, may be known across the country within from three minutes to an hour after the event has actually occurred. If no newspaper edition has yet been shot from guns to gain speed in delivery it is because the bright young men of the circulation department have overlooked it. Tomorrow it will be done at Chicago and next week it will be "old stuff" at Kalamazoo.

The point is that when radio tackles the news job in earnest it will have a problem worthy of its powers; a huge commercial undertaking brimming with wealth and of high social usefulness.

Overseas radio has for several years rendered good service to the press, in competition with cables, but nothing important has been gained that would not have been obtained by additional cable lines. As automatic radio transmission and reception increases volume and lowers rates, foreign news over all seas should become almost as fast and cheap as is news by land-line Morse in this country at the present time.

In the near future attempts will be



International

THE "BELINOGRAPH" AT WORK IN THE NEWSPAPER FIELD

By this apparatus, the invention of M. Edouard Belin of France, news pictures can be sent by wire or by radio. The device is in use in Europe for the transmission of facsimiles of bankers' money orders, the signature being reproduced with sufficient accuracy for all financial purposes.

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made to serve large numbers of newspapers with so-called "telegraph news" by means of radio-propelled, high-speed equipment, such as is now used in connection with the Morse wires. During the past three years, highly important developments have been made in this direction, the relay problem having been solved to a nicety.

An eight-hour-day Morse wire, carrying an average of 12,000 to 15,000 words, at an average cost of $13 a mile a year, let alone the heavy cost of hand sending, relaying and receiving, will be supplanted in the near future by a radio circuit equipped with relatively inexpensive automatic machinery which will be capable of transmitting over distances of a few hundred miles radius. Automatically, receivers on printing machines will receive 200 or 300 words a minute, or 100,000 to 140,000 news words during the period of press activity in the average evening newspaper office.

As the writer is the "father" of this application of radio-propelled, automatic news-printing equipment, and as the innovation (for business reasons) has not been announced to the public, a technical consideration of the matter is inappropriate in this article. But the fact should be noted that the news agencies are alive to the incalculable economies in cost, speed and wordage, of such automatic radio telegraphy.

No newspaper can publish 100,000 words of telegraph news a day without being a burden to readers. It would mean twelve and one-half solid pages of the average paper devoted to interests other than local news, features, advertising and pictures. The average city newspaper does not publish more than six or eight solid pages of local and telegraph news altogether.

But a heavy volume of received news is desirable in that it gives editors a wide range of selection. Speedy delivery is of tremendous importance. With high-speed radio delivery the press services will be able, for instance, to lay down in the office of every subscribing newspaper, within a half hour, a six-thousand-word President's message which was delivered to the reporters at the White House at the moment the President departed to read the address before Congress. Each editor would be able to make his own selections of excerpts instead of giving this important function into the hands of the press association editor.

International

RADIO IS MAKING POSSIBLE "A NEW KIND OF REPORTING"

When President Coolidge gave an after-dinner talk in New York on February 12th, the occasion was "covered" by a reporter who gave a word-picture of the happenings to the microphone—and then permitted the listening fans to hear the speeches for themselves.

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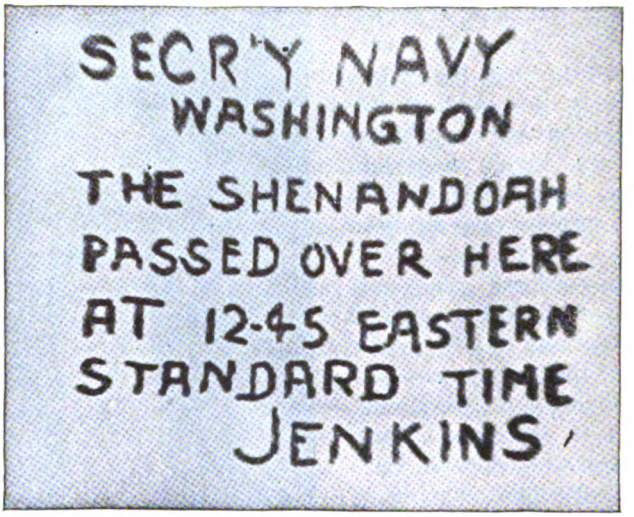

THE FORERUNNER OF THE RADIO NEWSPAPER

This written message was transmitted by radio, just as you see it here, by the apparatus invented by Mr. C. Francis Jenkins of Washington, D. C. Whole newspaper pages may be sent and received in this way including both type matter and illustrations.

It is possible, too, that rapid and cheap distribution of such news matter can be accomplished through the methods for the radio transmission of photographs recently devised by Jenkins in the United States* and by Belin in France. The entire text of a President's message, in typewritten script or in printed copy, could be photographed and the photograph broadcast by radio to subscribing papers. Photographs and texts have been broadcast thus by the Jenkins apparatus and are now being handled commercially (though by land-wire not by radio) by the telegraph service of the French Government.

A logical extension of this process will be the radio transmission of entire newspapers or parts of them. A news or feature page may be made up at a central office and photographed. The photograph may be sent by radio to receiving stations in the suburbs or in other cities. At these receiving stations an automatic apparatus will convert this radio photograph into type or plates from which the newspaper can be printed at once.

It would be quite possible, for example, to edit and set-up a newspaper in New York, transmit it photographically to a dozen cities all over the country and issue the identical paper (or certain identical sheets of a paper) simultaneously in all these cities, with no greater delay than now occurs between the completion and issuance of a single edition.

But it is more particularly the matter of direct news service to the reading public, and the question of what effect this may have upon newspapers, that both the radio men and the publishers are discussing today.

The huge newspaper publishing business is at present in the attitude of resisting this innovation. The several important press associations or services are insisting, with considerable success, that newspapers subscribing to their services shall make no use of their news on local radio broadcasting outfits, even if owned or operated in conjunction with such newspapers. The large independent radio broadcasters have been forced to collect their own news, if they desired to transmit news facts to their audiences. Press associations will not sell news to them.

*See "The New Radio Movies" by Watson Davis in POPULAR RADIO for December, 1923.

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The fifty-odd newspapers of the country that have established radio broadcasting services have used them mainly as free amusements, the cost being charged to good will and reputation for enterprise, items not to be neglected in the field of successful newspaper operation. Such news as the editors of these papers can collect, independent of press services, which in most instances is local news, may be available for radio broadcasting, but this is usually not the most important news. Even the *local* news of Associated Press members is controlled by that association, according to the by-laws.

For instance, in the case of the death of a President, the flash news would come to the newspaper from its press service wire. This news would be the property of the press association. The newspaper would have license only to publish it in its columns and would be expressly forbidden to broadcast it on the office radio equipment.

Rather than disapproving of this rule, many newspaper editors consider it a means of conserving the power of the paper to sell on the streets. If the average reader is acquainted with a news fact the purchasing motive, it is argued, is lost or, at least, impaired.

I think it is the experience of editors who actually have broadcast news that radio service has not seriously impaired the circulation of the newspapers, but the logic of the matter certainly implies that it might do so.

Yet the news reporting by some of the leading broadcasting stations deserves high praise.

International

RADIO COMES TO THE AID OF THE WIRE NEWS SERVICE

When all the land lines, telephone and telegraph alike, were put out of commission by the snowstorm of last February, radio took over the news service in Chicago and in many other cities and pinch-hit during the emergency. This picture was made in the offices of the International News Service in Chicago.

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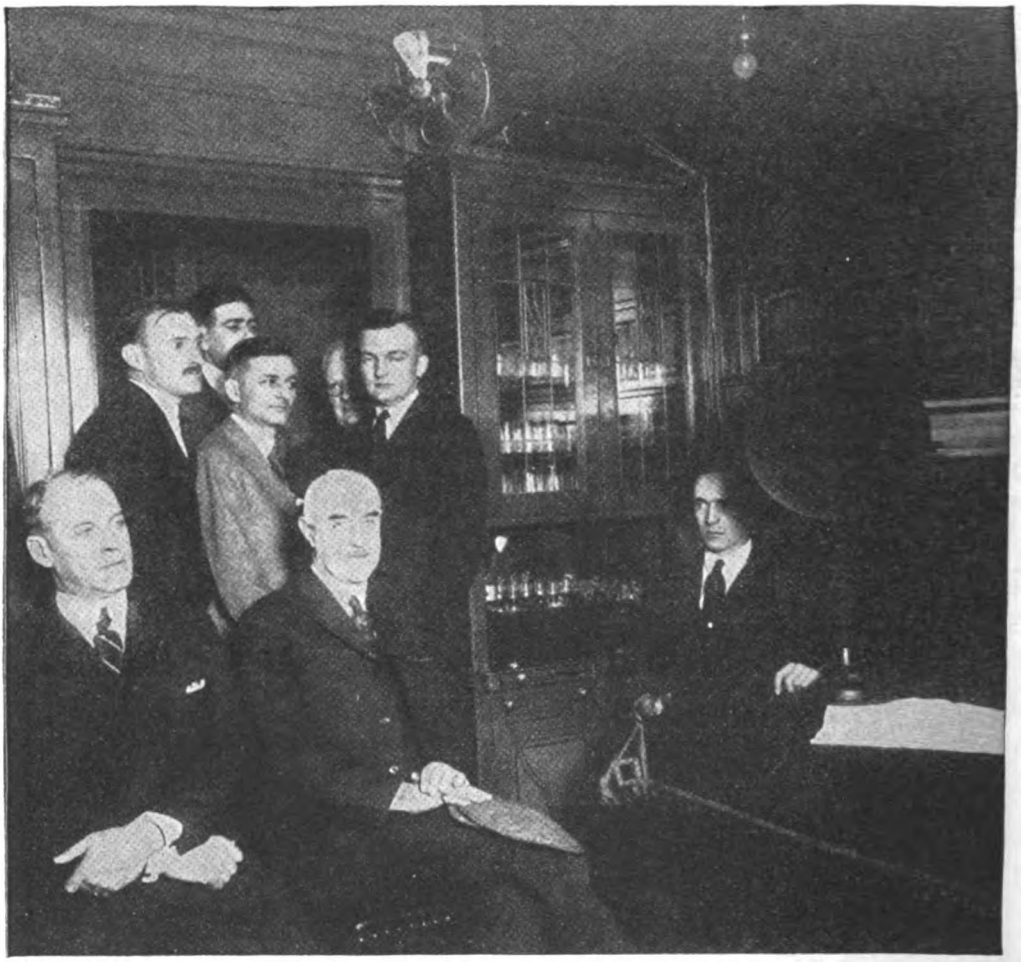

International

GETTING THE NEWS OF THE DAY BY RADIO ON MOVING RAILWAY TRAINS

When a group of officials of the United States Chamber of Commerce recently made a tour of the west, their private car was equipped with a receiver which enabled them to receive the news bulletins and other broadcast entertainment while speeding over the rails.

I recall particularly the report of a banquet a year ago in honor of the venerable French statesman Clemenceau. I had intended to be present at this banquet, but being detained at home, with my family about me, I listened to a radio report from our loudspeaker.

As I should not have been seated near to the Tiger's place at the table if I had attended the banquet, I am certain that I heard his address more distinctly at my home. Every word, every heavily drawn breath, the applause, in fact the whole spirit of the occasion was faithfully reported to me. It was by all means the finest news report I had ever received, opening my eyes to a new form of reporting, impossible to newspapers.

The station was announced and a clever observer, with a pleasant voice, began a description, all in the present tense, of the banquet room and the arrival of distinguished persons, making a more colorful news report than could have been written, to which was added

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the interest gained from instant contact with the facts as they occurred.

No feature was overlooked. The decorations, appearance of prominent men as they took their places at table, a satisfactory account of the dresses and ornamentation of the distinguished women; all this helped prepare the minds of the radio auditors for the real purpose of the meeting.

When Clemenceau left the hall, surrounded by a police squad, the announcer told this. He told, also, how the guests took leave and what was heard in the way of comment on the speech. Finally he closed the entertainment with a brief story of how the radio transmitter had been concealed in a bank of roses set directly before the Tiger's plate, of the fact that the speaker was averse to speaking into the radio and throughout the evening had been unconscious of the fact that perhaps a hundred thousand persons outside of the hall had been listening to his words; even to those deep sighs and to the gurgle of the water as he drank to clear his throat.

That sort of news reporting cannot be done by newspapers and surely it has its place in the scheme of American life.

For various reasons, aside from the chief reason of vastly increased cost of radio news service over newspaper news service, it is inconceivable that the future will see the newspaper supplanted by the radio. To my mind such dreams of radio promoters are as hollow as is the feeling of publishers that radio is to be feared and guarded against.

What may reasonably be expected from radio telephony in local broadcasting is a news service harmoniously supplementing and benefiting the printed sheet.

In this regard imagination travels rapidly: In the first place there must be a financial motive for newspaper publishers to accept radio as a means of public service. This must be more potent than the mere prestige attending it.

Inventions, now rapidly on the way, of methods of sending radio currents through controlled channels, may make it possible to "string" subscribers on a radio circuit even as on telephone, electric light or illuminating gas circuits. This may solve the financial problem. Perhaps the commercial scheme behind newspaper radio telephony will involve the placement of inexpensive receiving apparatus in the homes of subscribers, these being tuned to a central sending station. The key which would unlock this service to the subscribing family would be issued for a financial consideration.

It is easily possible that instead of being a financial burden radio service may become highly profitable as an auxiliary to the printed sheet. It is reasonable to believe, therefore, that if newspaper publishers do not accept local radio as a part of their public responsibility, outside interests will organize it and make it competitive to the newspapers.

Such radio service certainly would involve both news service and entertainment. The day will come, I dare say, when a newspaper in St. Louis, will subscribe for the service of the New York Metropolitan Opera and will give it to subscribers as regularly as the "Mutt and Jeff" comic strips are now furnished on the printed sheet.

Will Radio Help the Deaf to Hear?

So *many conflicting answers have been made to this question that* POPULAR RADIO *has undertaken an investigation on its own account and is at present conducting a series of laboratory experiments in cooperation with doctors and scientists. The results will shortly be published in this magazine.*

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Ajax Electrothermic Corporation

"HOT FROM THE RADIO FURNACE"

Dr. Northrup and an assistant are here shown pouring out the metal fused by the power of radio waves.

Melting Metals by Radio

There are many metals that you dare not melt in an ordinary furnace if you want to keep them pure because the dust and gases of the furnace enter the metal and spoil it. Radio offers a solution of this important industrial problem in Dr. Northrup's remarkable "radio furnace," by means of which no fire or dirt touches the molten metal at all—nothing but radio waves.

By E. F. NORTHRUP, Ph.D.

A GOOD many years ago the brilliant Henry Augustus Rowland, America's most original physicist, taught at Johns Hopkins University to a small group of students, of which I was one, the fundamental principles of electromagnetic radiation. These principles, as mathematically stated by Maxwell and experimentally verified by Hertz, were wonderfully presented.

The subject of ether waves was an abstruse one for the "young idea" to grasp. But we were eager and well I remember how our minds were gradually pried open and how our enthusiasm grew and our ambition rose high.

In those days it was only at centers of higher education that "pure science"

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could live. There were few commercial laboratories of research and none of them would have dreamed of working upon a subject like wireless waves—a subject that had no money in it!

But the attitude of the commercial mind has changed since then, not a little because of the chosen few who sat at the feet of the great Rowland and who went forth—some to distant places—and carried with them the torches he had lighted.

It was in 1896, about two years after I had listened to Rowland's lectures, that I found myself a Professor of Physics at Austin, Texas. It was in this state that some very early American experiments were made with electric waves, with electric tuning and with the actual wireless transmission to a considerable distance of electric signals.

G. W. Pierce, now a professor at Harvard University and an authority on radio, and Dr. Fritz Reichmann, then a student in the University of Texas, were my enthusiastic co-workers in the many experiments made on Texas soil.*

This was a long time ago but the principles then developed and used are exactly the same as are now used for melting steel, brass, silver and even glass, as well as many other highly refractory materials. They are the same principles that we employ in the Ajax-Northrup high-frequency induction furnace, not only for melting hun-

*The antiquarian can find many of these experiments described in the volumes of the *Electrical World* for 1897 and 1898.

A Maker of Modern Miracles

In his laboratory at Princeton University and later at Trenton, N. J., Dr. E. F. Northrup, distinguished American physicist and one of the first men on this continent to transmit messages by radio, has a small, dark-colored tube into which he can insert a steel bar and have the metal flow out in a few moments as fiery liquid steel!

In another small crucible he can attain the temperature of melted tungsten, the most refractory of metals.

Gold, platinum, iridium, molybdenum, yield at once to the tremendous heat of this simple little apparatus. What does it?

Radio!

This is the new radio furnace in which the most intense of electric heats is applied to metals and other substances without any contact with wires or other carriers of electricity. The heating is done entirely by electromagnetic waves—the same waves that are used in radio—which fall on the substance itself and heat it, without contaminating it with carbon vapors as does the electric arc.

In this authoritative article Dr. Northrup describes how this marvelous apparatus works.

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dreds of pounds of metal but for producing throughout a considerable space inside the furnace a higher temperature, in a space free of carbon gases and often in a vacuum, than was ever obtained before.

It is because these principles are the same, that radio fans are taking an interest in this new method of electric heating—a method that may be called, with perfect scientific accuracy, "heating by radio."

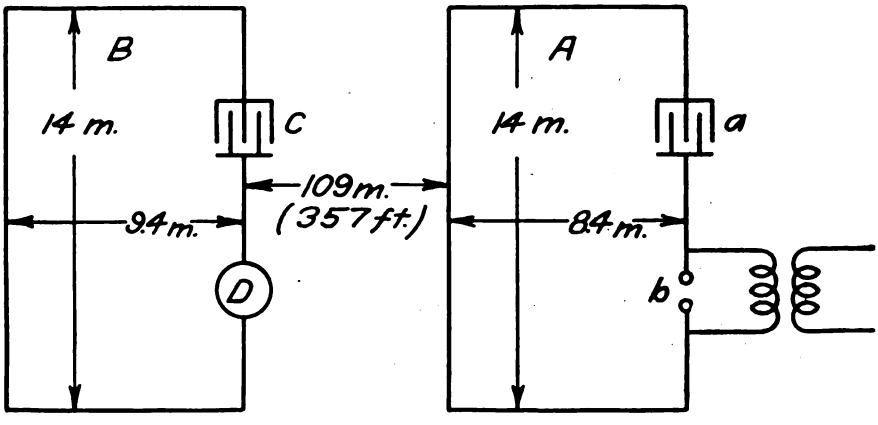
Indeed much of the actual apparatus used for this radio heating is likely to prove valuable to the radio expert in sending his dots and dashes, or maybe his voice, half way around the world.

The apparatus that we used in those early experiments in Texas consisted of two rectangular loops of bell-wire, as shown in the accompanying diagram. One of the loops contained a condenser and a spark-gap; the other contained a detector especially devised for the purpose and which consisted of a small silver disk suspended on a quartz fiber inside a coil of a few turns of wire.

No amount of direct current passed through the coil of this instrument would deflect the silver disk when the current was steady. Even a large current of commercial frequency would make only a very small deflection. But when the minutest current of radio frequency passed through the coil large deflections were obtained. The two loops were placed 109 meters (357.6 feet) apart, their planes facing each other, as shown in Figure 1.

We soon learned that to get deflections of large value it was necessary to tune the receiving circuit accurately to the transmitting one. This we did by varying the capacity of the condenser. As accurate tuning was approached the deflections of the detector became decidedly larger. In Figure 2 is shown one of the sharp resonance curves that we succeeded in obtaining at that time, one of the first radio resonance curves, I suppose, that was ever obtained.

The experiment thus described is only one of a large number of similar nature that we made using the oscillating-current galvanometer as our detector. For example, we constructed two similar Hertzian oscillators. One that acted as a transmitter was placed in one room of a building, while the other, acting as a receiver, was placed in a distant room of the same building. In the receiving oscillator the "detector" took the place of the spark-gap in the transmitter. The Texans were much amazed to see us



THE HOOK-UP FOR THE RADIO EXPERIMENTS OF 1896

FIGURE 1: *These two Hertzian loops were used by Dr. Northrup for the transmission and reception of what were probably the first radio signals ever produced on the American continent.*

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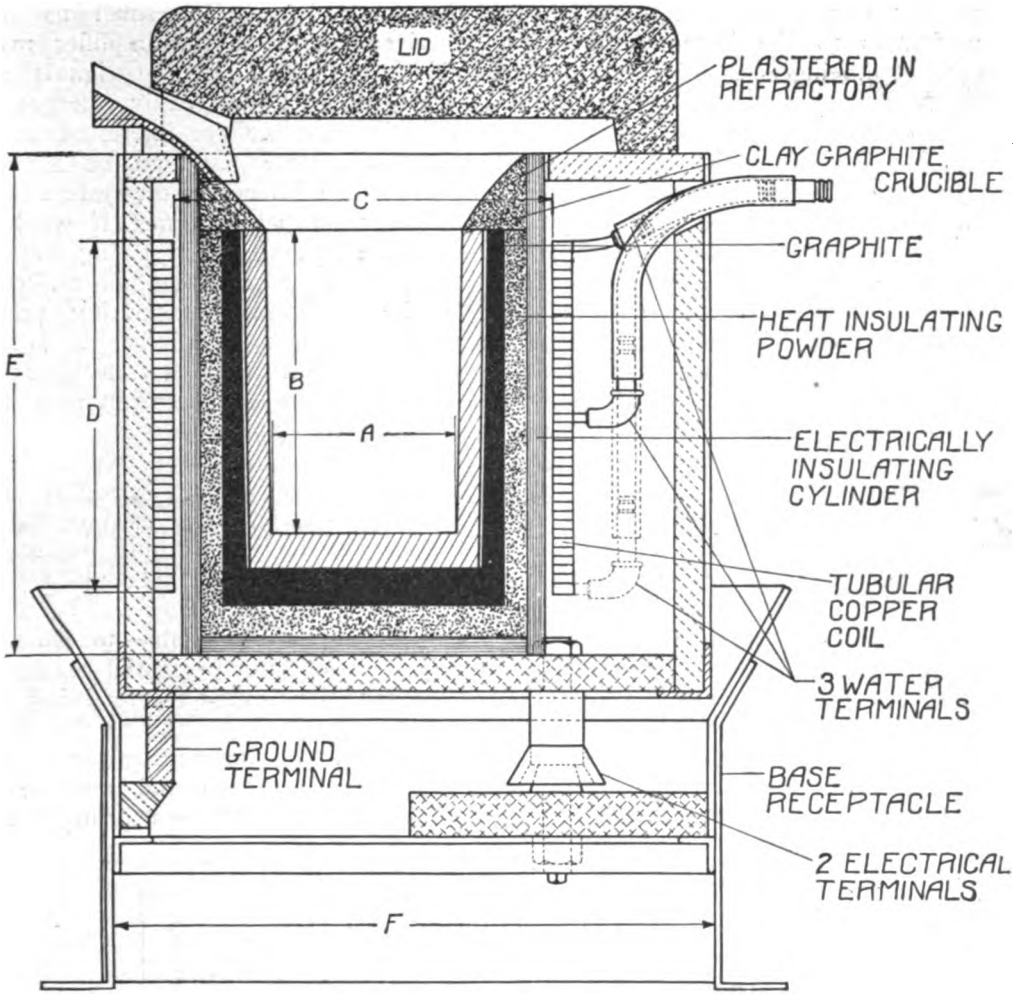

THE DESIGN OF THE RADIO FURNACE

The metal to be melted is placed in the space AB. An oscillating current in the water-cooled copper coil D supplies the radio waves that melt the metal.

thus transmitting signals from one part of a building to another through solid brick walls and without wires.

On December 25, 1897, I wrote:* "The experiments (which were those described above) are merely of scientific interest. . . . They give, in a manner, by numerical relation, confirmation of the much-talked-of electrical harmony."

How dimly the experimenters of that period, including the writer and his associates, visioned the future of radio communication!

Wireless waves produced with high-frequency current now ceaselessly cross and criss-cross each other without any mutual interference. They fill the ether about the earth. They are ever present in the seclusion of our homes. They go forth into every corner of our globe, and they make the whole world think the same thoughts and learn the same news at the same instant.

However, the inductive effect of high-frequency current surging in one circuit, whether loop or antenna, upon

*In the *Electrical World.*

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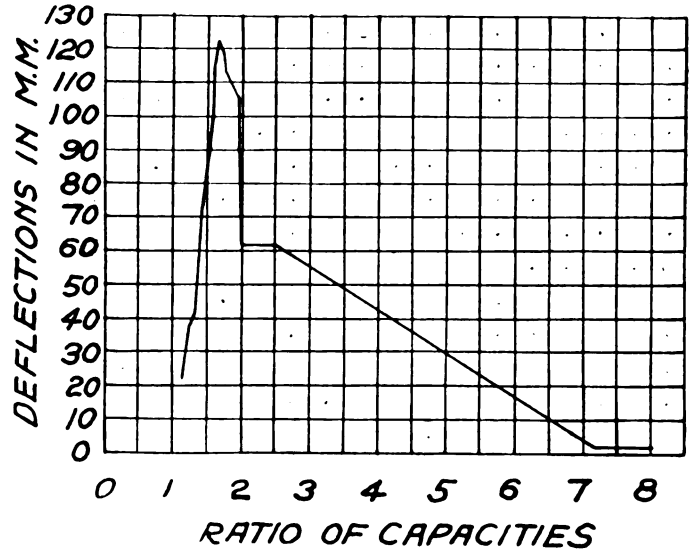
another circuit is not confined in its usefulness to the instant communication of intelligence. If one stops to consider the almost infinitesimal fraction of the energy radiated from a sending antenna which is intercepted by the receiving antenna, it seems fanciful to suppose that high-frequency oscillations could be used to set up, by induction, currents that will melt 500-pound charges of metal or raise substances to the blinding white temperature that will fuse tungsten. Yet such is the fact.

But in order to accomplish these results we must arrange our circuits very differently in one respect than when we wish to transmit intelligence.

For sending a signal to a great distance we are not concerned with the wasted power that radiates off into space and never reaches our receiving set. Indeed, of the total power supplied to the sending antenna the fraction that reaches the receiving antenna is inconceivably small. If turned into heat it would not perceptibly raise the temperature of a short wire the size of the finest hair. But small as this received energy is, the amplifier magnifies it so that all the signals are clearly received and easily interpreted. This is what we are interested in in radio—the clear reception of signals. The power efficiency of the system is of little consequence. In fact, if we look upon the sending and receiving stations of a radio transmission as an electrical system for transmitting power from one place to another it is the most inefficient electrical transmitter of power that has ever been put into useful service.

If, on the other hand, we wish to transmit power without wires from a sender to a receiver for the purpose of heating the receiver we must make this transmission of power take place with little waste or the method will be without value. We are able to do this only by meeting one essential condition. This condition is that the receiving circuit be placed very close to the sending circuit. In transmitting signals the coupling is very loose and must be so, for the distance between primary and



THE PHENOMENA OF "TUNING" WERE FIRST INVESTIGATED BY MEANS OF GRAPHS LIKE THIS

FIGURE 2: *Dr. Northrup describes in this article how resonance curves like that shown above (which was one of the first) were obtained in 1896 and how the phenomena of tuning were investigated by this means.*

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Ajax Electrothermic Corporation

THE RADIO FURNACE AND THE RADIO FIREMAN—THE INVENTOR

Each of these radio furnaces in Dr. Northrup's laboratory is a separate unit. The mercury arc, the condensers, the transformers and other accessories for each furnace are contained in the cabinets to the rear.

secondary may of necessity be half the circumference of the globe. But for the efficiency in power transmission which we must have for useful heating the coupling between primary and secondary must be very close, and no necessity prevents us from making it close.

The constructions that I shall describe very briefly for heating with high-frequency current conform to this necessary condition of close coupling. Heating by radio has become a practical success and many hundreds of kilowatts are so employed in many parts of the world.

Naturally if much power is to be received to become changed into heat, much power must be supplied. It becomes necessary, therefore, to build very powerful oscillators which will yield from ten kilowatts to sixty kilowatts of power, and at least sixty or seventy percent of this power must become changed into heat at a localized place—the furnace.

These oscillators are being manufactured for operation on single-phase, two-phase, and three-phase circuits. The brief description which follows applies to an oscillator for operation on a single-phase circuit. Such an oscillator will absorb from 20 kilowatts to 30 kilowatts from the supply main and will give by wireless radiation (over the distance of an inch or two) 14 kilowatts to 21 kilowatts to the material being heated. An oscillator for this purpose makes use of no unfamiliar circuits or unfamiliar principles. Figure 3 shows diagrammatically the arrangement of the circuits employed.

The transformer has its secondary

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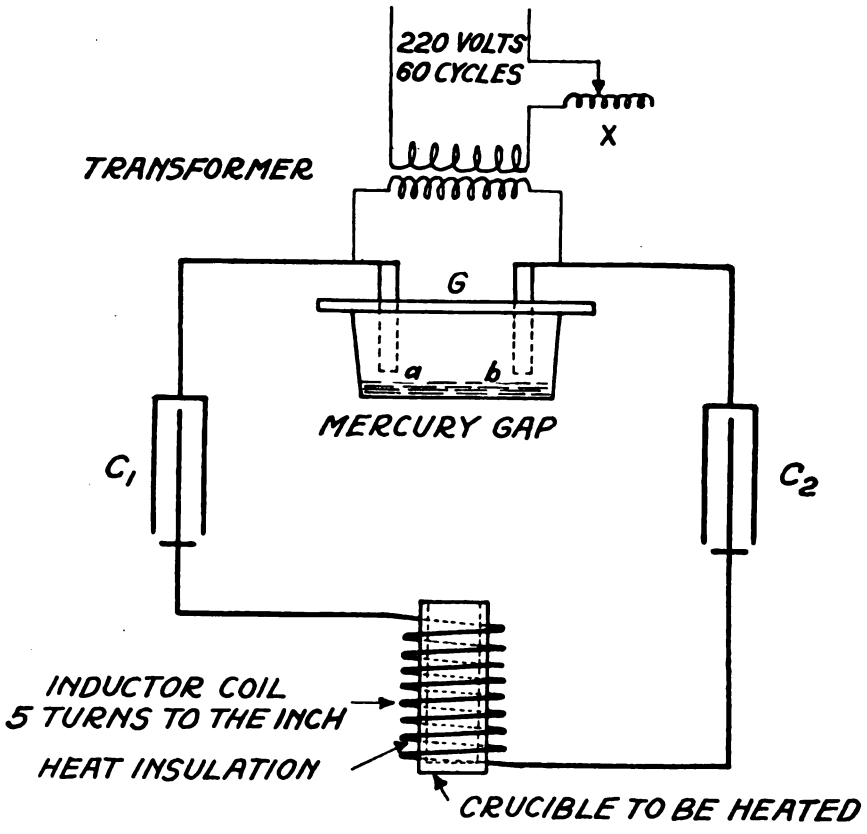

THE HOOK-UP FOR THE RADIO FURNACE

FIGURE 3: *An oscillating current produced by the special mercury arc G, is regulated by the condensers C_1 and C_2 and is fed through the inductor coil which surrounds the metal to be heated.*

which develops 6,600 volts connected across the double discharge gap G. The reactance X, placed in series with the primary of this transformer, limits the flow of current to a suitable amperage. In practice the transformer is so constructed that this reactance is an internal reactance inside the transformer itself.

The condensers C_1 and C_2 become charged to opposite polarity as the voltage supplied by the secondary of the transformer increases. Finally when the potential becomes high enough the double gap breaks down at points "a" and "b" and the condensers discharge themselves through the coil C. This discharge of the condensers is oscillatory. The electricity swings back and forth in the circuit shown in heavy lines exactly in the manner of a pendulum whose bob swings in a viscuous fluid. Gross matter, however, moves slowly while electricity moves fast, and in one second the electricity will make from ten thousand to fifty thousand complete oscillations.

If the high-frequency currents set up were discharged into a sending antenna they would give rise to waves radiating out into space of wavelengths varying from 30,000 meters to 6,000 meters. The waves, however, are not allowed to radiate into space but fall upon the mass inside the crucible and generate large currents in it which heat it. The mass in the crucible may be considered as an absorber of the radiant

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energy which in a radio system spreads out through space.

The crucible itself may have a wall of conducting material, such as graphite, or the mass inside it may be a conducting material, such as broken pieces of the metal to be melted, the wall of the crucible being non-conducting. As we are able to make this or the crucible (which acts, of course, as the secondary) but little smaller in diameter than the inside diameter of the coil, a very considerable proportion of the energy radiated from the coil gets caught and changed into heat. The rest of the energy is returned to the condensers and keeps the electricity oscillating until it has made several swings each of diminishing amplitude.

It is necessary in order to reach a high temperature to prevent the heat generated in the crucible and the mass within it from escaping. This is done by filling in the small space between the crucible and the coil with a heat insulator that will stand a high temperature, such as powdered magnesia.

Experience has shown that the coil itself is best made by winding edgewise a single layer of hollow, flattened copper tubing. Through this flattened tubing a small stream of water is kept flowing. This water keeps the coil cool and its resistance low. When a furnace is made in this way one may melt platinum in a crucible and the molten metal may be less than one inch away from the inside of the inductor coil without the coil heating sufficiently to feel hot to the hand.

The discharge gap used in this apparatus consists of an approximately oval iron box with a flat bottom. The box is partly filled with mercury, and the discharge occurs between the mercury and the ends of two amalgamated, hollow, water-cooled copper electrodes. The electrodes pass in through glass insulators in the manner of an ordinary spark plug. By turning a wheel, the electrodes can be raised and lowered, thus varying the length of the discharge gap and the power delivered to the furnace by a considerable proportion of its maximum.

This gap functions in a remarkably steady and satisfactory manner. This is largely due to an extraordinary property possessed by mercury. It is able to quench an arc instantaneously whenever a series of oscillations have become considerably reduced in amplitude. This quenching action of mercury is improved when alcohol vapor or, better still, when hydrogen gas, fills the discharge gap-box. This quenching or disruption of the arc is entirely automatic. When the arc is cut off the condensers at once begin to re-charge; the gap again breaks down, and there is thus produced a regular repetition of wave-trains.

As the gap chamber is tightly closed very little noise issues from it. A gap of this construction when operated single phase will readily handle 25 kilowatts.

If we were to remove the crucible from the coil of one of these furnaces and then straighten out the coil and connect one end of it to the earth, the generated waves of electromagnetic energy would be radiated out into space just as from an antenna. A minute portion of these waves could then be intercepted at a great distance by a receiving antenna and we would have a wireless system for transmitting intelligence instead of the device we have described for producing elevated temperatures and melting the most refractory substances.

Common basic principles can often be traced among contrivances which at first sight appear to have nothing in common. In this case we see the principles familiar to the radio engineer, pressed into service for use of the metallurgist and chemist, for the melter of glass, of non-ferrous metals, of the precious metals, of steel alloys, and for the many users of high and controllable temperatures obtained by electric heat.

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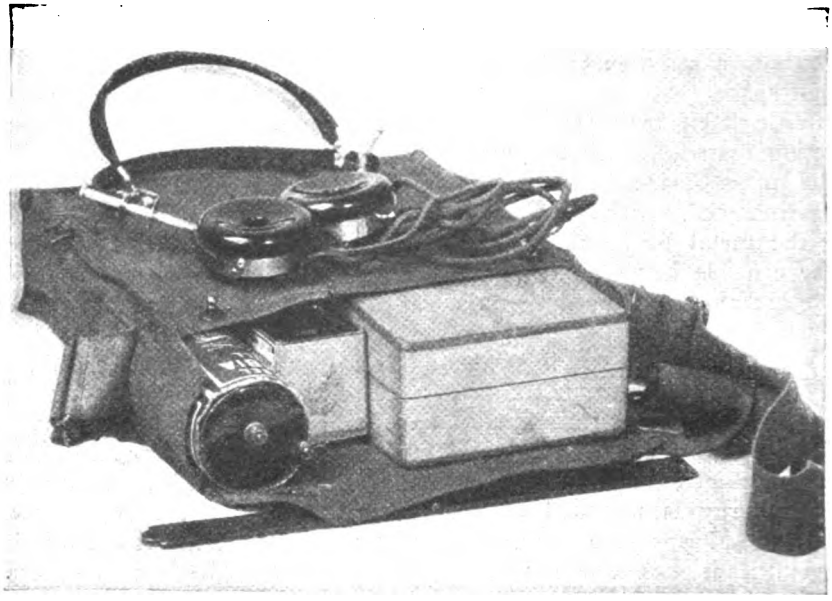

THE ENTIRE RECEIVER FITS INTO AN OLD ARMY GAS MASK PACK
This pack also carries the complete accessories—tubes, telephones, batteries and antenna equipment.

A Compact Radio Kit for a Spring Hike

Attach a short length of antenna wire to a limb of a tree or a fence, spread out the set on the ground, connect up the telephones and batteries—and listen in!

By H. W. SINCLAIR

WITH the tiny radio receiver (briefly described here), scarcely larger than a man's hand, it is no longer necessary for the tourist hiker to be without his favorite sport of "listening in" on the radio concert world while he is out in the woods.

By merely disconnecting the phones and batteries the entire set may be put into a canvas carrying case ten inches square. An army gas mask equipment serves admirably. To use this portable receiver it will only be necessary to string up a temporary antenna and tune in on the radio world.

It is a far cry from the old-fashioned receiver with its multiplicity of knobs and dials to this single-control outfit which is no larger than a cigar box; the outside dimensions of the box being five by nine inches, and two and three quarters inches deep.

The new design is the result of experimentation by the writer*, who for some months has been seeking to arrange a receiver which could be used by Boy Scout Troops while engaged in hiking programs incident to their scout training.

*Mr. Sinclair is a Boy Scout Executive of Middletown, Ohio.

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It is evident that in the production of this instrument, a radio set which is at once readily portable, efficient and inexpensive has been achieved.

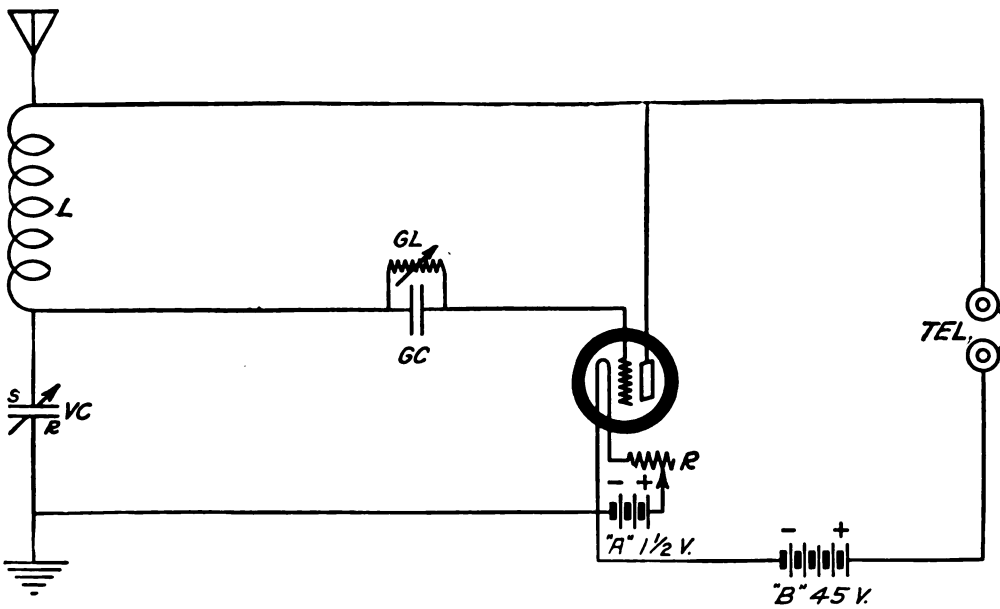
As may be seen in the illustrations, dry cells are used for power to light the filament of the WD-11, or UV-199 detector tube, and these batteries, together with the miniature "B" battery shown, slips into the side compartment of the gas mask bag which is used as a carrying case.

Another unique feature is the extremely small space taken up behind the panel. This is accomplished by the use of a late design in variable condensers which is very shallow. The model used in constructing this set being of a capacity equal to the conventional twenty-three plate size, yet it only requires three quarters of an inch clearance as against the five or six inches usually allotted. It is recommended that either a Miami, a Dubilier Variadon or a Connecticut variable condenser be used here, on account of the small space they occupy.

A multiple telephone connector is supplied which allows four pairs of headphones to be plugged in series with the plate circuit, making the instrument available for a number of listeners at one time.

The circuit used resembles both the ultra-audion and the Colpitts circuit, having the most desirable qualities of both these famous hook-ups. In operation the set is remarkably selective and sharp tuning, little body capacity being noticeable in adjusting. A variable grid-leak aids somewhat in adjusting regeneration and in clearing the tone of signals.

Perhaps one of the most interesting features to which the little set may be adapted is its wavelength range in reception. By simply changing the size of the honeycomb coil in the antenna circuit the whole range of wavelengths from amateur telegraphy on 175 to 200 meters,



HERE IS THE CIRCUIT YOU MUST FOLLOW

Connect up the coil L (size L-50) and the condenser VC (.0005 mfd.) and an ordinary mica grid condenser GC (.00025 mfd.) and a variable grid-leak GL. The tube may be either a WD-11 or a UV-199 or a C-299. The latter two tubes will require three dry batteries, however, and the first tube requires only one, which cuts down the weight of the pack; the batteries marked on the diagram are for the first-mentioned tube. The resistance R should be about 6 ohms for the WD-11 and 30 ohms if the other tubes are used. Compare the designations on this diagram with those on the two pictures on the following page.

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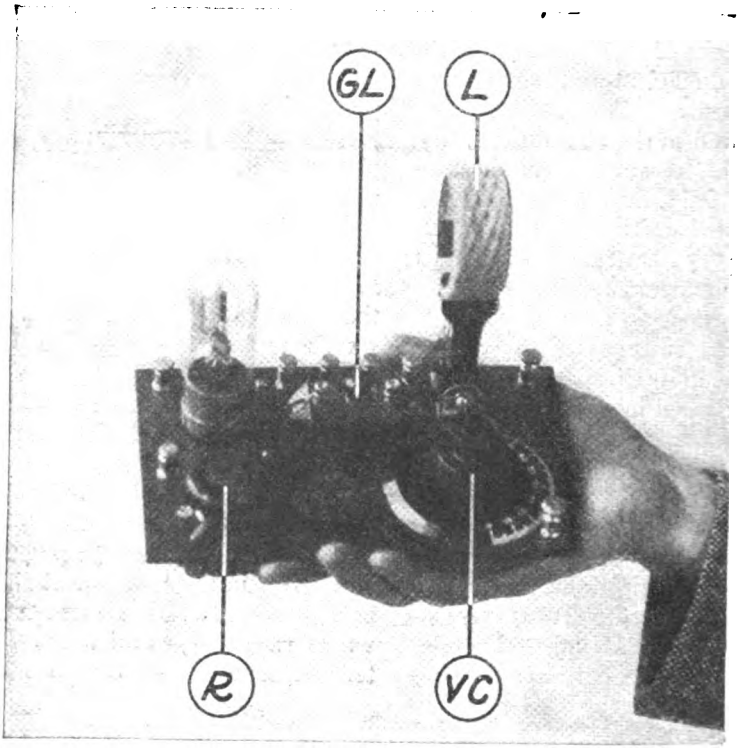
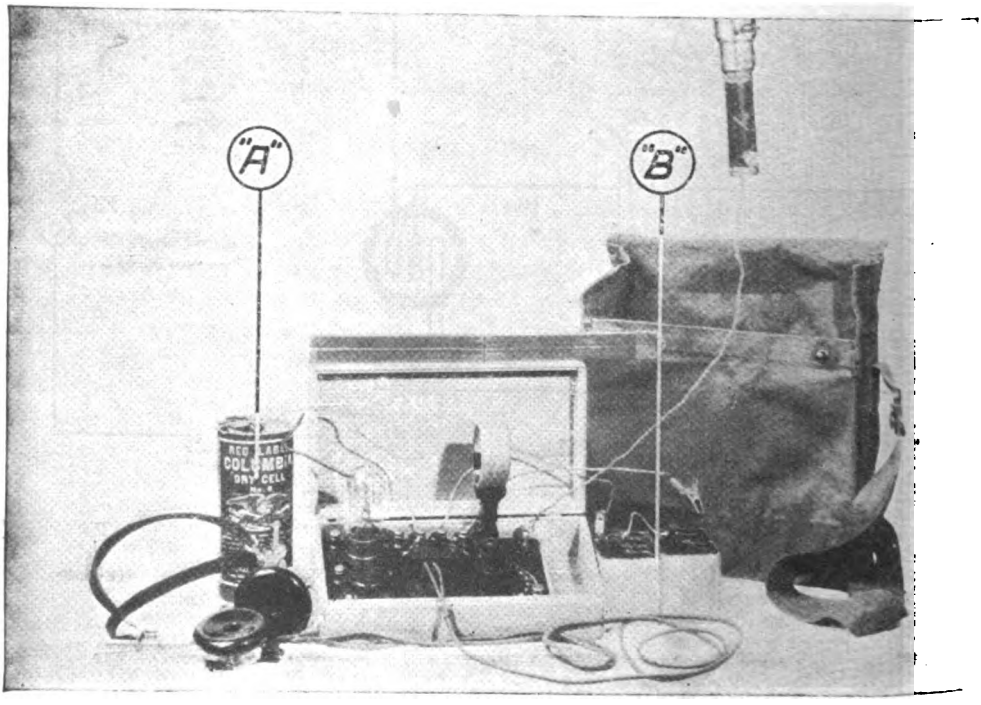


The upper picture shows the receiving unit taken out of its cabinet; the lower picture shows the receiver set up for listening in. It is connected to a lamp socket.



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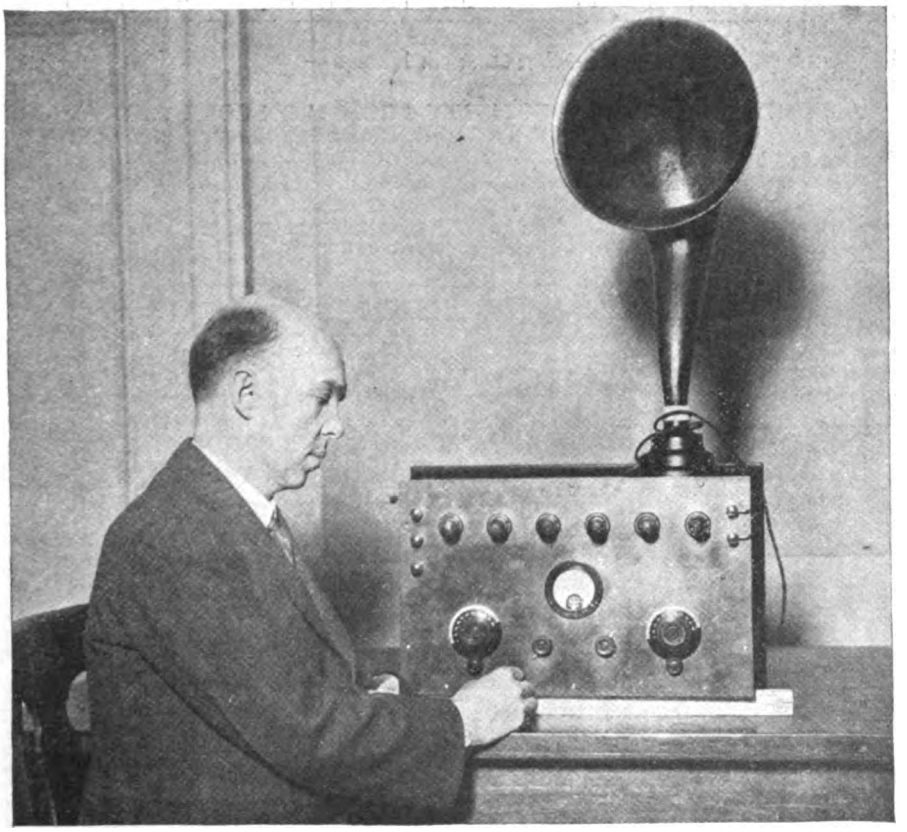
radiophone broadcasting on 300 to 500 meters, up to the long-range stations on commercial and navy wavelengths can be picked up at will.

Phenomenal success has been had with reception on a one-hundred-foot antenna located in Southwestern Ohio, the following stations being logged, clear and distinct, with one dry-cell tube: New York, 600 miles; Schenectady, 450 miles; Buffalo, 300 miles; Detroit and Chicago, 350 miles; Davenport, 550 miles; Dallas, 900 miles; and Havana, 1,150 miles.

Good results have been obtained up to 500 miles range using a lamp-socket antenna plug.

The apparatus is so simple in operation, the only tuning control being the variable condenser in the antenna circuit, that even the uninitiated novice can pick up music without any previous knowledge of radio or of the operation of sets. This feature makes it doubly valuable for use on outing parties, where any member of the crowd can hook in a concert without waiting for the owner of the set to perform any dial-juggling stunts.

The set, however, is *not* recommended for city use, as it re-radiates strongly. For use in the open spaces, where there are no neighbors to interfere with and where a portable set is required, it is ideal.



Wide World

THE INVENTOR OF THE REGENERATIVE CIRCUIT EXPERIMENTS WITH A NEW SUPER-HETERODYNE

E. H. Armstrong (above) and Harry Houck have just made public their latest work on an important improvement for the super-heterodyne. It is the use of a "second harmonic" oscillator. The set is of extraordinary sensitivity.

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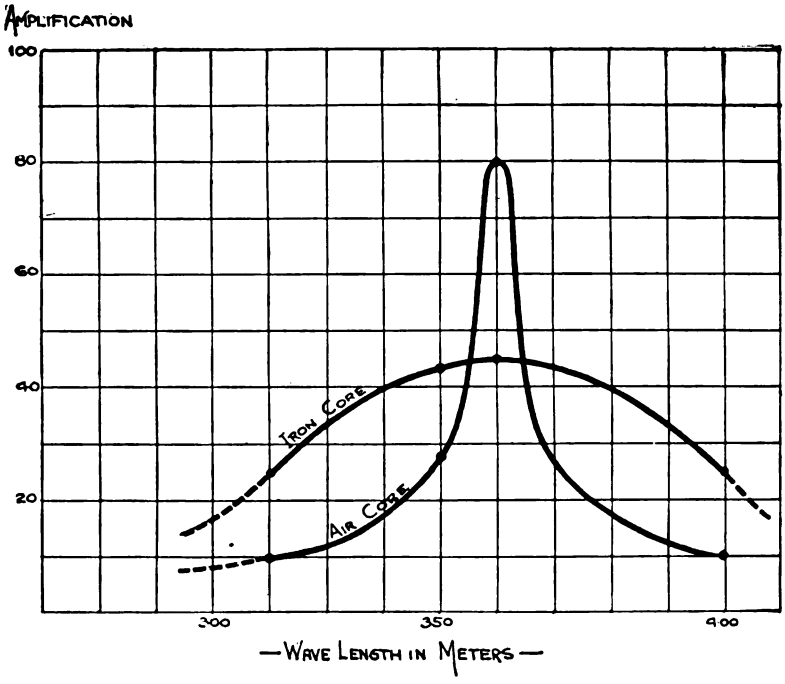

A COMPARISON OF SELECTIVITY FROM IRON-CORE AND AIR-CORE TRANSFORMERS

FIGURE 1: *These two resonance curves show the relative selectivity obtained with an air-core transformer and an iron-core transformer for radio-frequency amplification. Notice how much greater amplification is obtained on 360 meters with the air-core transformer. On wavelengths other than this, however, the iron-core transformer gives the greater amplification.*

HOW TO GET THE MAXIMUM

Radio-frequency Amplification

Various types of radio-frequency amplification are now much in the eye of the radio public and many advantages are claimed for each. But there are also disadvantages of each. This article tells of both.

By GEORGE LEWIS

RADIO-FREQUENCY amplification has been used for a number of years in the design of radio receivers for commercial communication purposes wherein the wavelengths range from 600 to 25,000. At the longer wavelengths, corresponding to those used in transatlantic communication, little difficulty is experienced in obtaining satisfactory results.

The advent of radio broadcasting at wavelengths between 360 and 400 meters, however, introduced so many new problems in transformer design, that the manufacturers of radio-broadcasting receivers seemed to favor the use of a detector and several stages of audio-frequency amplification. The operation of the vacuum tube as a radio-frequency amplifier offers far greater application

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than any other service at the present time. And while it is true that the vacuum tube may be utilized effectively as an audio-frequency amplifier and as a detector in receiving circuits, yet signals cannot possibly be received unless the strength is sufficient to operate the detector.

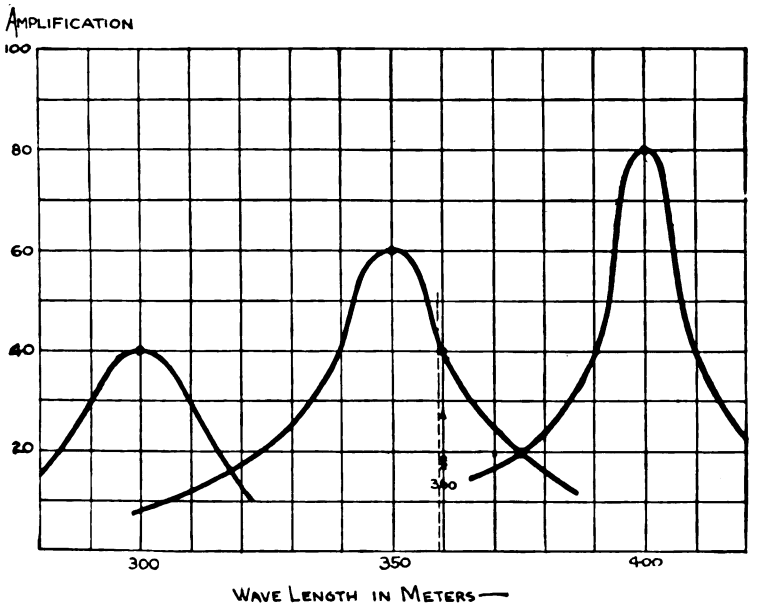
In the early days of radio, communication over a certain distance was looked upon as a problem of transmitter power, as it was considered that a certain energy would be required to operate a detector and unless the transmitting station was capable of delivering this energy at the receiving point, communication could not be established. Today the problem has been altered from *transmitter power* to *receiver sensitivity*—a much less expensive proposition, brought into effect by radio-frequency amplification.

In other words, the more modern receiving equipment brings about the same effect as moving the transmitter up toward the receiver.

It is an accepted fact that the output of a detector does not vary in direct proportion to the input voltage applied to the grid, but as the grid potential is lowered a certain "cut-off grid voltage" is reached below which no response is registered in the plate circuit and the electron tube ceases to function as a detector.

This means, that signals from radio stations located at a distance so far from the receiver as to prevent potentials greater than the "cut-off grid voltage" to be applied to the detector tube of the receiver, cannot be recorded, even though a number of stages of audio-frequency amplification are employed.

At applied potentials greater than this "cut-off grid voltage" value the output or response in the plate circuit of the detector increases more rapidly than the



A RESONANCE CURVE FOR A RADIO-FREQUENCY TRANSFORMER

FIGURE 2: *In this case the transformer has a winding tapped in three places. The highest amplification is obtained on 400 meters. The next highest peak would be at approximately 250 meters and the lowest tap would give a peak at 300 meters. At wavelengths between these taps, however, the amplification would drop off quite severely.*

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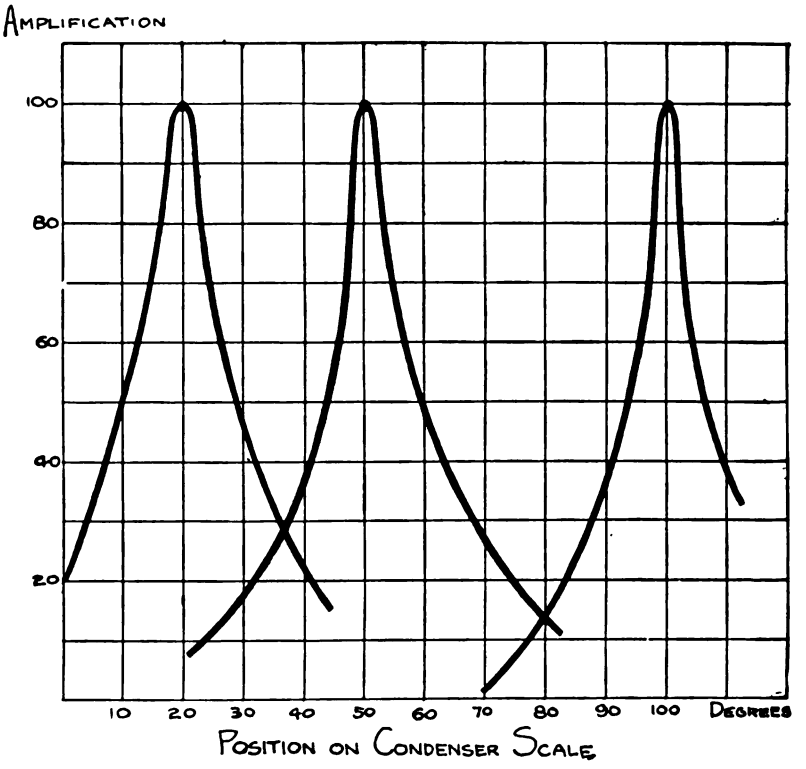
square of the input potential. Therefore, any arrangement that tends to increase the potential delivered to the detector will not only greatly increase the volume of detected signals, but make it possible to receive stations which would be inaudible otherwise, due to the inherent "cut-off" factor of the detector tube. This condition immediately recommends the use of radio-frequency amplification.

Radio-frequency amplification, in general, may be grouped in the following classes:

1; *inductive coupled*
Air-core transformers (aperiodic)
Air-core transformers (tuned)
Iron-core transformers (aperiodic)
Iron-core transformers (tuned)
2; *direct coupled*
Tuned impedance
Choke-coil arrangement
Resistance coupled
Electrostatically coupled

Practically all of the systems of radio-frequency amplification have been used from time to time with some degree of success, either in this country or in Europe. However, the particular construction of the American vacuum tube, together with the shortness of the waves utilized for broadcasting, has tended until recently to confine the practice in this country to inductive-coupled transformer arrangements.



A RESONANCE CURVE FOR A TUNED TRANSFORMER

FIGURE 3: *This device would be used with a variable condenser. The condenser settings are shown along the bottom edge of the chart. These settings correspond to the wavelength ranges shown on the charts in Figures 2 and 3. Using this method of amplification, the resonance peak could be shifted along over the entire range with higher constant amplification at the various wavelengths. For instance, at a setting of 20 on the condenser, corresponding to a wavelength of about 300 meters, the amplification could be considered as 100. By simply varying the condenser throughout the entire scale, the peak can be shifted to cover all wavelengths (within a certain range) with equal efficiency. This is shown on the graph, by the two additional curves for a condenser setting of 50 and 100 respectively.*

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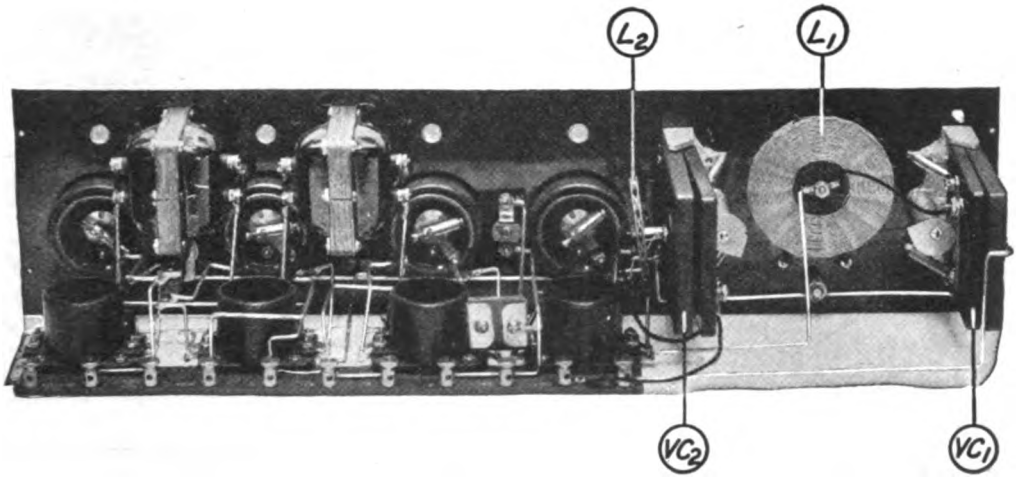

A RECEIVER EMPLOYING TUNED-RADIO-FREQUENCY AMPLIFICATION

FIGURE 4: *The antenna circuit is tuned with a coil, L1 used in connection with a variable condenser, VC1, of "book" type. The plate circuit of the radio-frequency tube is tuned by a similar coil and condenser, L2 and VC2, respectively.*

During the past year, however, a number of manufacturers have developed and marketed receivers in which the radio-frequency amplification was accomplished by a fixed ratio. Transformers of the direct-coupled type are composed of two inductive windings which, when operated in connection with the grid-to-plate capacity of the vacuum tube, bring about resonance of the desired frequency. This arrangement for transformation is limited by the extremely narrow wavelength band over which the transformer will efficiently operate. A fixed-ratio transformer with an air core is remarkably efficient in its operation. However, the sharp resonance curve confines all practical operations to wavelengths quite close to its resonance period.

This limitation is shown by the sharp-peaked resonance curve of Figure 1.

Here it is evident that the receiver operated with this transformer will receive radio concerts at a wavelength of 360 meters with a signal intensity or volume of 80. Other stations broadcasting on a wavelength of 400 meters will be received with a volume of 10.

The air-core transformer has been utilized with a fair degree of success when the windings are provided with a switching arrangement wherein the turn ratio and the resonance period can be set for several separate wave zones.

For instance, a transformer may be constructed with three taps so connected to the windings that a resonance is obtained at 300, 350 and 400 meters. An amplification curve for a transformer of this class is shown in Figure 2.

It will be noted that the highest amplification point is at 400 meters, and that all of the other resonance points are lower. This is due to the resistance introduced when the coils are tapped. The 400-meter position utilizes the whole coil. The other positions do not, but have "dead ends" or inactive sections, which absorb a part of the energy.

While the amplification obtained at 360 meters is only 40, as compared to the 80 listed for the transformer in Figure 1, this tapped transformer can be used more efficiently at *all* wavelengths between 275 and 425. It is readily appreciated that the strength of received signals is not uniform between the wavelengths here listed, but stations transmitting at wavelengths of 300, 350

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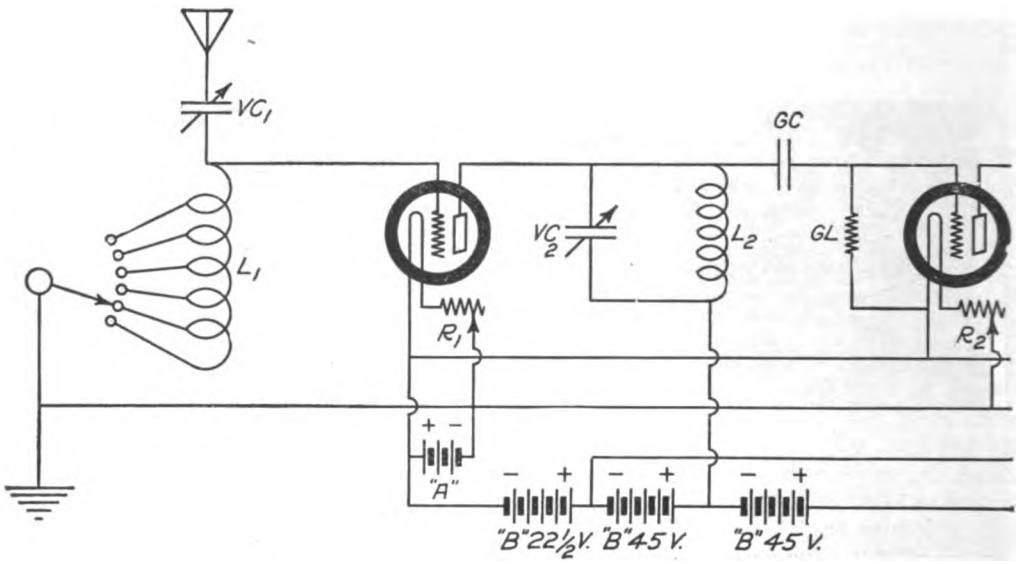

HOW TO CONNECT UP THE INSTRUMENTS

FIGURE 5: *This electrical wiring diagram shows the proper way to connect up the instruments in order to incorporate radio-frequency amplification in a set such as shown in Figure 4. Such a set will have the same resonant characteristics as given in the graph in Figure 3.*

and 400 meters are received with a maximum signal strength, and those at 275, 320 and 370 meters are received with reduced volume.

A great majority of the radio-frequency transformers in use at the present time, instead of using tapped windings so as to obtain tuning peaks or high-amplification points as described, introduce a magnetic core which tends to broaden the useful wavelength band. The construction of this transformer is exactly the same as the air-core transformer except for the introduction of the magnetic core. The influence of the magnetic circuit in broadening the resonance curve is shown by the low, broad curve of Figure 1, wherein the sharp resonance period of 360 meters is not obtained, as is the case when the core is removed. While the volume of the received signal is reduced to 45 in comparison with the 80 obtained when the core is removed, the signal volume at 300 and 400 meters *is increased.*

Receivers that embody transformers of the types described above have been operated with a certain degree of success during past years where all of the radio broadcasting stations of this country were licensed to operate on wavelengths of 360 or 400 meters. Stations transmitting at wavelengths greater or lower than these values are what may be termed beyond the useful amplification wavelength zone of these transformers.

As a result of the vast amount of interference caused by the six hundred American broadcasting stations transmitting on two wavelengths, the Department of Commerce Radio Conference recommended that licenses be issued to permit stations to broadcast on various wavelengths between 200 and 600 meters. Since the recommendations of this conference have been put into effect an overwhelming number of complaints have been received where stations operating on the higher and lower wavelengths could not be received with the desired signal strength. The reasons for this are apparent when the above facts are considered.

The sharp resonance curve shown in Figure 1 represents the amplification

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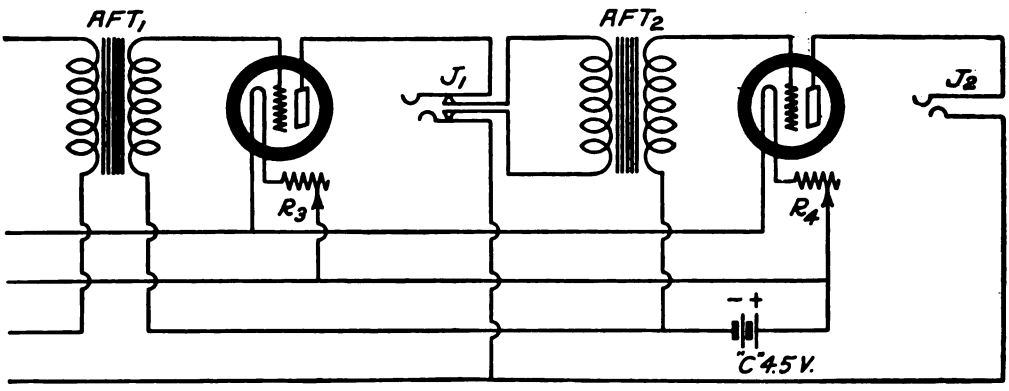

at various wavelengths on each side of the resonance point with a transformer composed of two coupled windings having a definite value of self inductance. As the windings are composed of a great number of closely associated turns, they bring about a high value of distributed capacity between the various turns of the windings. The effect of this combination can be represented by a condenser having the same value as the distributed capacity and connected between the terminals of the coil.

In the particular instance of the transformer of Figure 1, the inductance and capacity of the windings are purposely proportioned in the design of the transformer to be resonant at 360 meters, thereby enabling the radio concerts to be received with the greatest intensity at this broadcasting wave.

Windings designed to have an appreciable value of distributed capacity cannot be included in the class of efficient inductances as the condensers formed between the windings are notoriously inefficient, due to the poor dielectric properties of the insulation covering the wire. A more efficient design may be arranged by altering the construction of the inductance so as to reduce the internal or distributed capacity as far as possible and then bring about the resonant condition at 360 meters by tuning the circuit by means of an efficient variable condenser. An arrangement of this class is termed "tuned-radio-frequency amplification," and represents the most efficient form of radio-frequency amplification available at the present time. Not only is the amplitude of the received signal increased from 80 to 100 by the introduction of an efficient inductance and condenser, but the wavelength range of the system can be greatly increased.

As an example, assume that the condenser and coils were selected so that resonance was obtained at 600 meters when the condenser was set at 100 degrees, corresponding to its full scale, or maximum capacity, position.

The resonance curve obtained at this setting is shown by the right-hand curve of Figure 3. This arrangement would bring about resonance at 400 meters when the condenser was set at 50 degrees, as shown by the middle curve of Figure 3. The 300-meter resonance curve is shown at 20 degrees. If resonant at 360 meters, the condenser would be adjusted to a position between 30 and 40 degrees where the 360-meter signals would be received with the same intensity as the three waves already shown. Here we have a

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radio-frequency amplifier of practically uniform amplitude, that is, amplification with equal intensity at any wavelength over the range of the instrument. The simplicity of construction and the ease with which the tuned-radio-frequency amplifier is operated cannot be overestimated.

Figure 4 illustrates a receiver of this class wherein the inductance consists of a special form of basket-woven coil of an extremely efficient type used in combination with a tuning condenser.

Figure 5 shows the wiring diagram of a receiver which uses this type of tuned-radio-frequency amplification.

In this type of amplifier the condenser plays an important part. Experimenters and investigators have appreciated the technical advantages embodied in this principle of amplification. However, the popularity of this system has been retarded by the discouraging reports circulated by those constructing such an amplifier with condensers having high dielectric losses or strong external or stray electric fields. The condenser having the high loss reduces the over-all efficiency of the device to that of the ordinary transformer and the stray field, prevents the proper wavelength adjustment.

It is claimed at times that there is little difference between radio-frequency amplification and audio or voice-frequency amplification except a slight increase in the range of the receiver.

In conclusion it may be stated that radio-frequency amplification will not materially increase the power or volume of strong signals, and that *all* magnification of power *must be accomplished* by audio-frequency amplification. However, the following inherent advantages found in radio-frequency amplification are most important in the design of an efficient radio receiver:

1—An increase in the receiving range of a receiver;
2—Amplification without distortion of signals;
3—Possibilities of employing loop or frame-type antennas;
4—Reduction of the possibilities of interference caused by re-radiation when used with regenerative receivers.

Kadel & Herbert

THE PRINCE OF WALES CONGRATULATES AN ENGLISH AMATEUR—

for his achievement in transmitting and receiving messages from the United States on a home-made set. The amateur is Cyril Goyder of the Mill High School.

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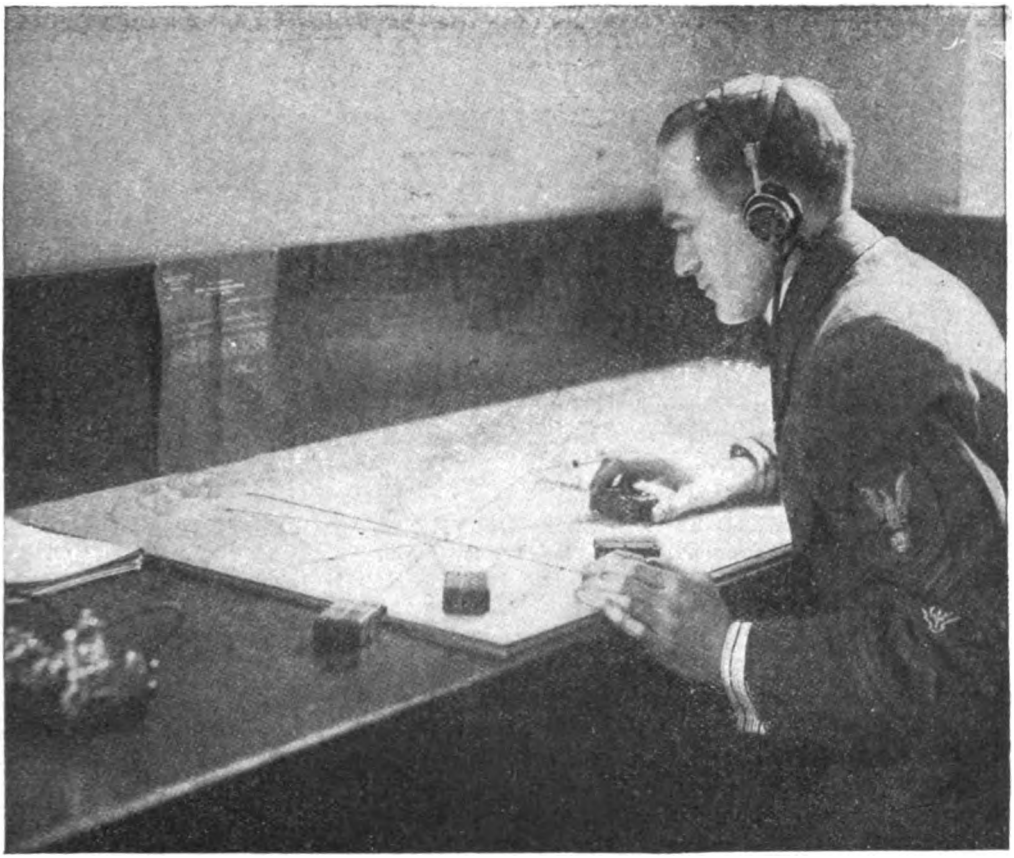

S. R. Winters

How Radio Locates Ships at Sea

By S. R. WINTERS

THE picture at the top of this page explains how a radio operator ashore can determine the position of a ship at sea more accurately than the captain can do it for himself. The chart shown is at the central compass-control station ashore, connected by land wire with each of the radio stations that possess a direction finder. The strings on the chart pass through holes at the positions of these radio stations.

Suppose that the operator at one of these stations hears a ship's transmitter working. The ship may not be calling for bearings but the operator listens just the same. His radio compass shows him the exact direction of the ship from his station. He sends this over a land wire to the compass-control station where the chart is. The man at the chart grasps the weight attached to the cord representing the compass station, pulls out the cord and puts it on a line which represents the ship's bearing from the compass station. Two or more other compass stations send similar reports and other strings are adjusted. Where the strings cross, there the ship is.

Not so long ago a British ship hit the New Jersey sand within a thousand feet of where a navy compass man had told the captain she would strike.

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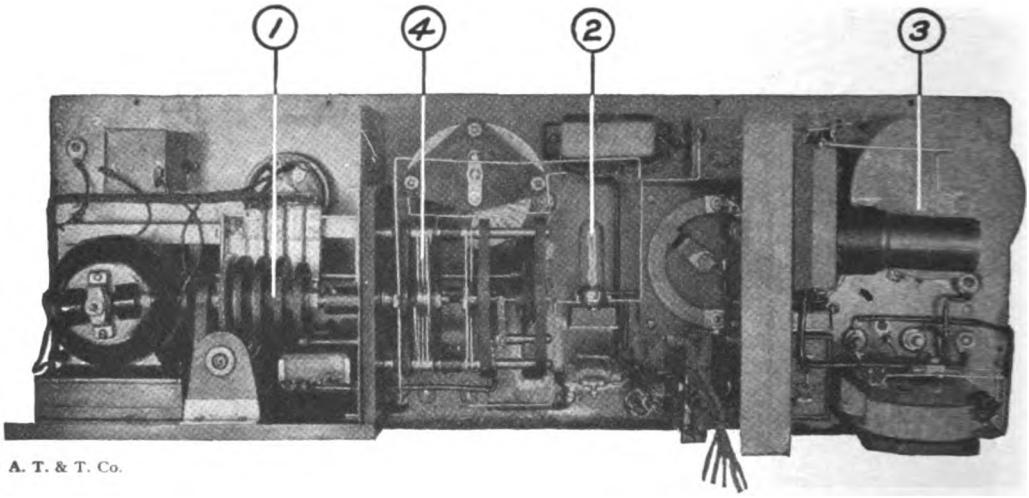

A. T. & T. Co.

BEHIND THE SCENES OF THE STATIC RECORDER

FIGURE 1: *The motor at the left drives the frequency selector 1 and the variable condenser 4. At the right of center is seen the local oscillator tube 2, and at the extreme right is the thermocouple 3, and associated circuits.*

Getting Static's Autograph

Here is a practical experimenter who goes out looking for static. Not content with listening to it, he has developed a scheme for automatically recording both its presence and its magnitude. This matter of automatically recording static may have a real idea behind it; we had better not, just offhand, award it the blue ribbon for useless occupations. Static is one of the things which is constantly "on the air" and which is a source of annoyance, not only to the B.C.L., but also to the amateur and the radio engineer. May it not be that the best method to pursue in attempting to circumvent it is to learn all we can of its variations in intensity from minute to minute throughout the various seasons, and from what direction it comes and what appear to be its causes? From continuous observations, certain deductions can probably be drawn regarding (for instance) the times of day and year when long-distance work can best be carried out, and the amount of power which would be required to get messages through with the degree of certainty required in rendering commercial service. The following account of automatic recording of static is written by Dr. Austin Bailey, of The American Telephone and Telegraph Company laboratories:

By AUSTIN BAILEY

THE origin of static and its wave form have considerable scientific importance. Some work along this line has been done by European experimenters. However, the thing of most immediate importance in radio-communication engineering is an accurate, quantitative method for the measurement of radio noise.

In our work on measuring radio noise, there have been developed several methods of determining the *noise level* in the ether which involves the use of the human ear.

These methods, while very useful, require that someone take the readings, and in order to obtain any considerable amount of continuous data, the observations become decidedly tiresome. In addition to this there is the personal element which introduces considerable variation in the observations—depending upon the individual who is obtaining the data. For these reasons we have thought

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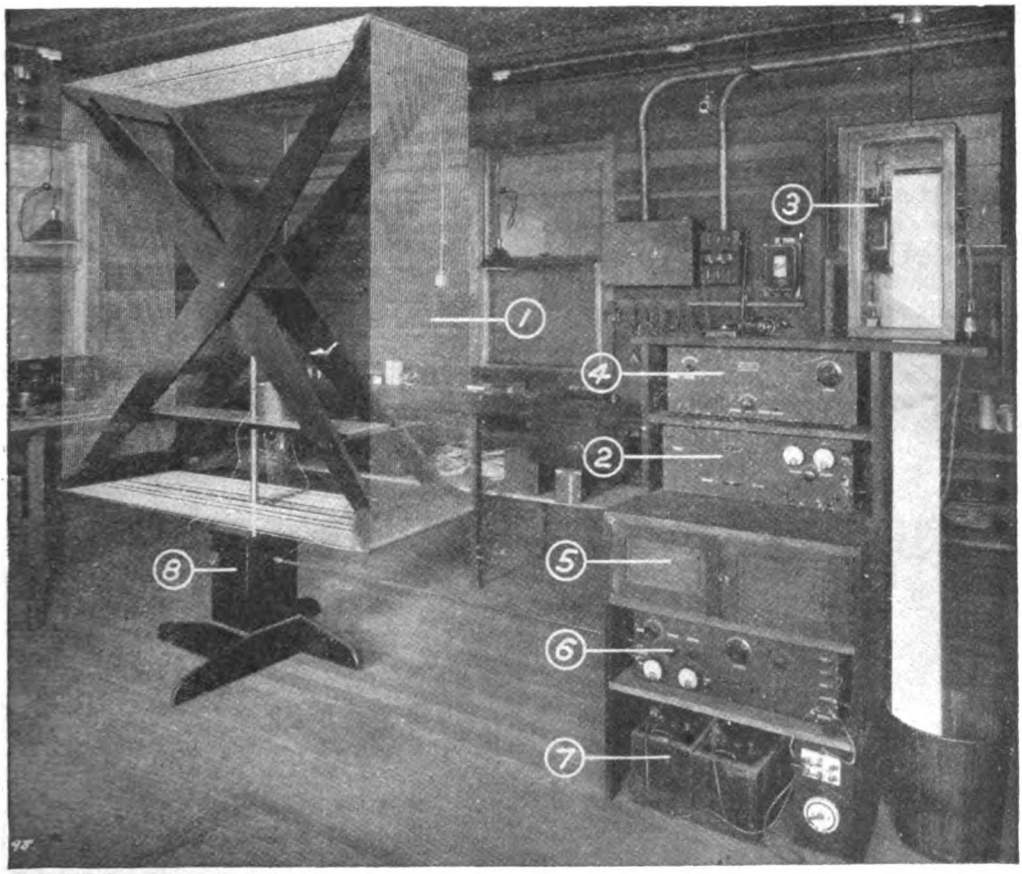
it worth while to develop an automatic means of taking and recording readings of the static noise level by means of some instrument which could run continuously twenty-four hours a day, every day in the year, and which would require only occasional attention.

The way in which this is done is really simple, although it does require some special apparatus.

The radio noise is picked up on a loop antenna and passed into a radio-frequency amplifier. The output of this amplifier passes through a transformer into the heating element of a thermocouple. The D. C. output of the thermocouple operates a recording galvanometer of ordinary type, which gives a continuous record of the variations in the current which heats the thermocouple. A picture of this radio appliance is shown in Figure 2.

This is really quite simple, and it is only necessary to obtain a quantitative value which will correspond to a given deflection on the recorder. This is accomplished by introducing into the loop a comparison signal from a local oscillator of the same frequency as that of the radio noise, and by measuring the value of this input and recording the corresponding output. In this outfit the calibration is completely made without the attention of an operator. The auto-



A VIEW OF THE STATIC STATION

FIGURE 2: *The large loop 1, is supported by a base which also contains the resistance box 8. The rest of the apparatus is bunched together; 3 is the automatic recorder, 2 and 4 are the amplifiers, 5 is the "B" battery box, 6 is the instrument shown in Figure 1 and 7 is the storage battery.*

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matic calibration is shown on the right of the sample record for August 26, 1923 (Figure 3).

Starting at the right-hand side of the chart at 6 A.M. the observer sees a record of static until about 6:20 A.M. Suddenly the recording mechanism closes a circuit that starts a motor. The motor then operates a contactor switch which closes the filament circuit of the local-signal input oscillator, decreases the amplification of the outfit by a fixed amount, and connects the galvanometer so that for three minutes it records the value of the local signal which is put into the loop. At the end of this time the galvanometer is again connected in its normal position so that it records the output of the amplifier.

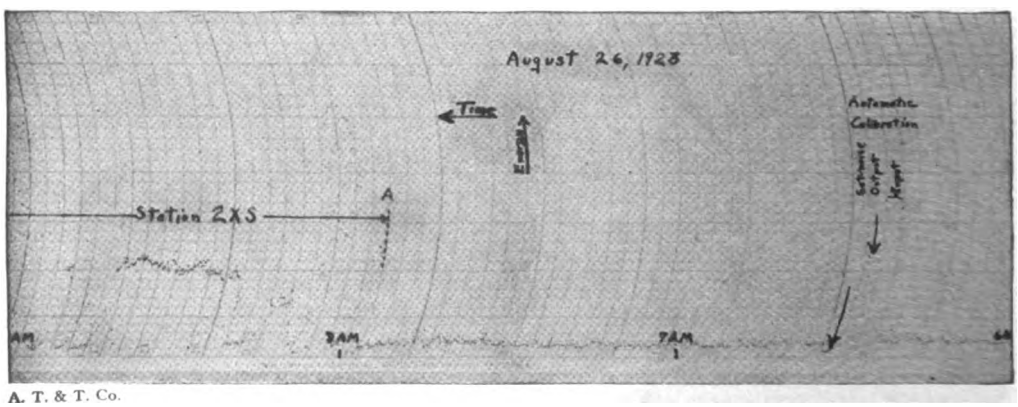
A variable air condenser is rotated slowly by the motor so that it changes the frequency of the oscillator, insuring that the local signal is exactly in tune with the loop. The record of this part of the calibration appears as a resonance curve on the chart under the heading *"output."*

Following this resonance curve, the contactor switch closes a relay which "short circuits" the input of the amplifier, and for two minutes records only the zero correction on the galvanometer. This is shown on the record under the heading *"set-noise."* At the end of this period, the set is restored to its original condition and the recording of static continues.

One of the interesting details which was observed almost immediately upon placing this outfit in operation was the abrupt change in the value of the static which occurs at sunrise.

Practically any operator will tell you that if you listen around the sunrise period you will notice this change, but one would never expect it to have so great a magnitude as the change shown on the sample chart given in Figure 4 for April 13, 1923. Here you will notice that just before sunrise there is an increase in the amount of radio noise or static. As the day breaks, this noise starts to diminish rapidly and reaches a minimum shortly after sunrise.

This change in static occurs every morning regularly at sunrise and does not depend upon weather conditions. With the receiving loop placed in the east and west direction this change is most pronounced and probably the reason for this is the fact that some rather sudden change in transmission occurs between dark and daylight. As the earth revolves on its axis, the sun is shining on one side while the other is in complete darkness. This gives rise to a shadow wall that separates day and night. For radio waves—and static comes under



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AN AUTOMATIC CHART RECORD OF STATIC

FIGURE 3: *The small dotted curve is a record of the strength of static received by the automatic station for the early morning hours of August 26, 1923.*

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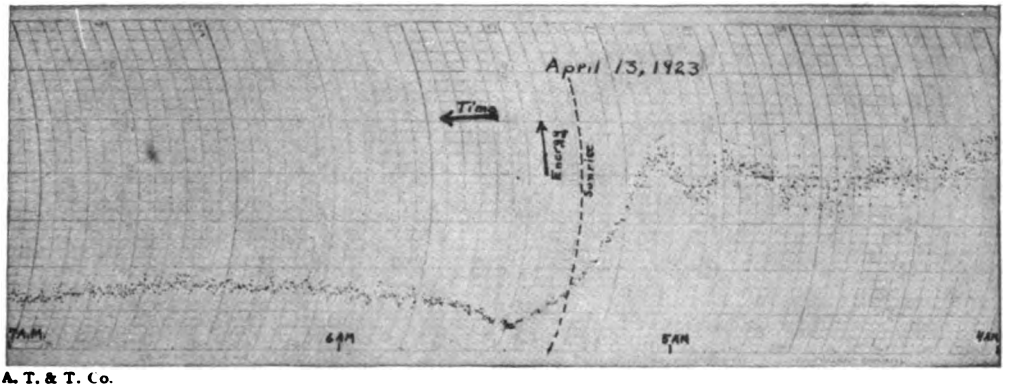

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NOTE THE SHARP DECREASE IN STATIC AFTER SUNRISE

FIGURE 4: *This is the same kind of a chart as shown in Figure 3, except that the time period in this case covers the early hours of April 13, 1923. The changes in the strength of static before and after sunrise are well shown.*

this heading—this shadow wall appears to act as a giant reflector or refractor.

Now, as practically all of the static received on the eastern coast of the United States originates in the southwest, one may see that as the shadow wall passes the station, it appears to reflect or refract the static waves from the southwest and acts as a shield and greatly reduces the static.

Often other sources of interference besides static are present; when they are strong enough and lie within the narrow band of frequency on which the loop receives, they will, of course, be shown on the record. Occasionally a transmitting station of considerable power will suddenly come on and will give quite a deflection. Such a place is shown at A on the chart in Figure 3 for August 26, 1923. Station 2XS located at Rocky Point, L. I., which transmitted telephone conversation to London last January and has since been used for testing purposes, "came on," and because it was so much stronger than the static, had the effect of completely masking it.

Of course, in using results obtained on a recorder, a great deal of care must be taken to interpret the records correctly, otherwise erroneous ideas will be obtained.

Static, which to so many is a constant source of annoyance, has become for a few persons a very interesting phenomenon and one which deserves a great deal of study regarding its magnitude, its causes and its origin. The records thus far taken tell very little about the real origin of static but they do give very interesting results regarding its magnitude and from what localities it seems to come.

How to Use Your Radio Set on Your Vacation

THE *rapid strides that are being made in eliminating the old static bugaboo promise to give radio a far bigger vogue among the fans this summer than ever before. In the coming issue of* POPULAR RADIO—*for June—will appear the first of a series of articles that will describe in detail just how to use a radio receiver on your motor car and on your pleasure boat, and how to install it in your summer camp.*

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SAND TESTS ON TWO GOOD TELEPHONE DIAPHRAGMS

The diaphragm at the left is vibrating as a whole, causing the sand grains to collect in a uniform ring around the magnet poles. The one at the right is vibrating in two parts, with most of the sand collected on the line between them. So long as the sand makes a symmetrical pattern like either of these the receiver is behaving properly.

How to Test Telephone Receivers

WITH GRAINS OF COMMON SAND

At a meeting of the Royal Society in London last year, Prof. MacGregor-Morris of East London College, exhibited an ingenious device for making the vibrations of a telephone diaphragm visible to the eye. The sand figures that show the vibrations appear in less than a second after the sand is sprinkled on the diaphragm, this being only a small fraction of the time needed for any other testing method.

By PROF. J. T. MacGREGOR-MORRIS, M.I.E.E.

ABOUT three years ago, during the course of an examination of the properties of the so-called "humming" or "howling" telephone, Professor E. Mallett and the author had occasion to determine the various modes in which a standard 60-ohm telephone-receiver diaphragm was vibrating.

It was thought that a convenient method of investigating the matter would be to use the well-known method invented over a hundred years ago by the Prussian physicist, Chaldni; it consists in sprinkling sand on a vibrating plate in order to determine the position and form of the nodal lines.

With this object in view the ebonite cap of the telephone receiver was bored out so that a much larger portion of the metal diaphragm was exposed to view, but so that enough of the cap was left to enable the diaphragm to be gripped as firmly as ever. The receiver was clamped in a stand so that the plane of the diaphragm was horizontal and faced upward.

The receiver was then connected in circuit with an ordinary vacuum-tube oscillator, so that by varying the electrical capacity in the oscillator circuit

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the receiver diaphragm could be forced to oscillate at any desired frequency from 500 cycles a second up to one which was well above the limit of human hearing.

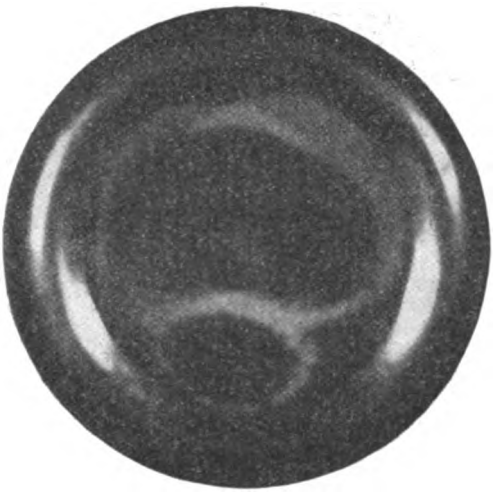
If now, some fine dry sand be lightly sprinkled over the diaphragm, any characteristic mode of vibration, if present, will at once be rendered apparent by the figure in which the sand grains arrange themselves. On varying the frequency of the oscillating tube circuit certain sand figures spring into existence with almost surprising sharpness as soon as the frequency imposed by the oscillator corresponds exactly with the natural frequency of the diaphragm.

At least twelve different figures have been obtained in this way, each corresponding to a different manner of vibration of the diaphragm. Two of these figures are reproduced in the accompanying illustrations showing the sand arranged, respectively, in a line and in a circle.

This method of testing by means of an oscillator and sand figures enables a rapid check to be made of the correctness of adjustment of the working parts of a receiver. As evidence of this statement there is reproduced herewith a third figure showing a great lack of symmetry in the arrangement of the sand and, therefore, in the vibration of the diaphragm. This lack of symmetry is due, probably, to the distances of the pole pieces from the diaphragm being unequal.

As experience is gained with this method it is probable that the usual opening of the telephone ear-cap will prove to be sufficient to allow of a sand figure being obtained and judged for symmetry. If so, it will be possible to test receivers without enlarging the opening in the ebonite ring.

It will be clear that for the characteristic frequencies at which the diaphragm tends to vibrate naturally, a definite amount of electric energy supplied to the receiver will result in a more powerful response of the receiver diaphragm to these particular notes than for frequencies far removed from them.



AN IMPERFECT RECEIVER

The unsymmetrical arrangement of the sand shows that the receiver is not working correctly. Probably the poles of the magnet are improperly adjusted so that one is farther from the diaphragm than is the other.

In music it is well known that the quality of a note produced by different musical instruments of the same pitch depends on the relative intensities of the various harmonics constituting that note. Bearing this in mind, we see that any undue emphasis upon one or more of the constituent harmonics of a note will distort the character of the note. A particular telephone diaphragm may easily alter the quality of a particular note so that the instrument which produced the note may be entirely unrecognizable.

There are many other causes of distortion of sounds by telephone receivers and their circuits, but this is one of the more important and is easily tested by sand figures in the simple way here described.

¶ *"Will radio haul our trains?" See* POPULAR RADIO *for June.*

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From a photograph made for POPULAR RADIO

AN 80,000-VOLT CIGAR LIGHTER

This novel "use" for high-voltage electricity is devised by Mr. S. N. Baruch of New York. The current used is of high frequency as well as high voltage; that is why there is no danger to the experimenter.

WHAT CAN WE DO WITH 3,000,000 VOLTS?

The greatest scientific mystery of this decade is the relation between ether waves and matter. What is the electron? How are radio waves produced and how do they affect electrons and atoms? What is the ether? One of the most promising ways of attacking these problems is by high-voltage electricity.

By THOMAS ELWAY

SCIENCE has found a new tool, a new weapon to assist the more complete conquest of the forces of nature. It is the availability of electric voltages measured in millions instead of in thousands—voltages hundreds of times greater than the scientists of even twenty years ago would have dreamed of being able to control and to use.

Nor are these tremendous voltages mere scientific toys. Although the production in the laboratory of potentials up to 2,000,000 volts is less than two years old, it has resulted already in the

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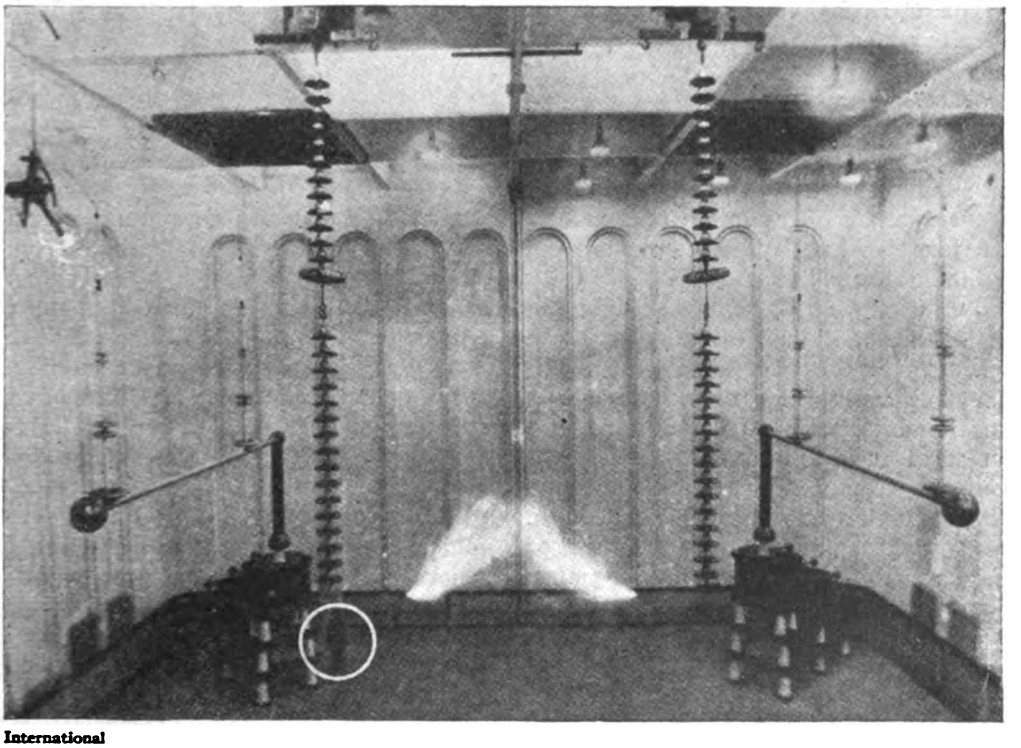
acquisition of experimental data of the greatest value to the design of electrical machinery and to other problems of electrical engineering, including the design of antenna systems for high-powered radio stations.

It is probable, scientists believe, that the application of these high voltages to the problems of physics will result within a year or two in still more fundamental advances. We may get clues to the real nature of matter and electricity; to the fundamental radio problem of what constitutes the disturbances in space that we call ether waves; perhaps even to that most interesting of all scientific problems, the problem of the nature of life!

What has been accomplished so far is scarcely more than the mere production of the high-voltage charges. A potential of 1,000,000 volts was attained for the first time nearly ten years ago, but it was difficult to control with the apparatus then available and was little used. Within the past three years interest in high-voltage work has revived. A potential of 1,000,000 volts was generated again by two of the larger engineering laboratories, that of the General Electric Company and that of the Westinghouse Company. The latter company succeeded in building a single transformer capable of producing this potential. Simultaneously the Pittsfield laboratory of the General Electric Company passed the million-volt figure and produced discharges at the tremendous potential of 2,000,000 volts, some of them, perhaps, even more than this.

Out in California the Southern California Edison Company is finishing the



International

A MILLION-VOLT ARC TRIES THE QUALITY OF INSULATORS

In this experimental laboratory at Freiburg, Germany, new designs and materials for electric insulators are tested with a potential of 1,000,000 volts. The figure of the man (inside the white circle) indicates the size of the arc.

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construction of a million-volt experimental laboratory at Pasadena and the California Institute of Technology, jointly with the great astronomical observatory at Mount Wilson, has assembled, to work in this laboratory, probably the most distinguished group of physicists and chemists ever gathered under the roofs of a single institution. Here in Pasadena there will begin this year the most comprehensive attack ever attempted on the problems of matter, of energy and of ether waves. Together with the million-volt weapon that they are preparing, the California scientists will have the best apparatus and the most highly trained assistants that science can suggest. No one can predict what they may not do. The news from Pasadena in the next two years may easily prove to be the most important news in the world.

The 2,000,000-volt potential that is already an accomplished fact, the 3,000,000 volts or more that we can have, probably, at any time that we can afford the money for the necessary apparatus, bring us close to the natural high-voltage discharges that we call lightning. We are surpassing Benjamin Franklin and the famous kite. We not only tap the lightning; we *make* it.

Just what the real voltage of lightning is, is still something of a mystery. The scientists of the General Electric Company, as a result of their experiments on the duplication of lightning effects on small scale laboratory models, estimate an average potential of some 50,000,000 volts for a good sized flash. An English investigator, Professor C. T. R. Wilson, believes in much higher figures, reaching even to 1,000,000,000 volts.

On the other hand, Professor Harris J. Ryan of Stanford University reaches much lower estimates. He has found by experiment that the length of a spark produced by a certain voltage increases tremendously with the high voltages. Although moderate voltages give sparks of only about one inch of length for each 10,000 volts, 3,000,000 volts would give, Professor Ryan thinks, a spark eighteen miles long. It seems to him, therefore, that natural lightning may be between 2,000,000 and 3,000,000 volts, quite within the range of the potentials now becoming available in the laboratory.

Whoever may prove to be right in this argument, whether lightning has the two or three million-volt value of Professor Ryan or the fifty million volts or more demanded by the other engineers, it is obvious that our laboratory resources begin to approach it. The late Dr. Steinmetz was able to blow up pieces of trees and to destroy toy villages with his artificial bolts. More important practically, it has been possible to use these available voltages to test insulators, to study the behavior of dielectric materials exposed to very high potentials, to study the electric surges in power lines induced by lightning flashes and to investigate many similar problems of power-line engineering.

It has been possible, too, to apply some of the facts learned to the problem of protecting large radio antenna systems from lightning bolts and from the induced surges caused by lightning. When the experiments are a little more complete it will probably be possible to generate artificial static and to study in this way the real nature and control of the radio disturbances caused by lightning and by other sources of atmospherics.

But the most fruitful field for high-voltage research is likely to be found, I believe, in the fundamental problems of physics. One of the striking things about physical science in the past thirty years is the way in which it has pushed its investigations of the behavior of matter into conditions of temperature, pressure and the like not naturally available on earth and never before attainable here.

Over a hundred years ago, for ex-

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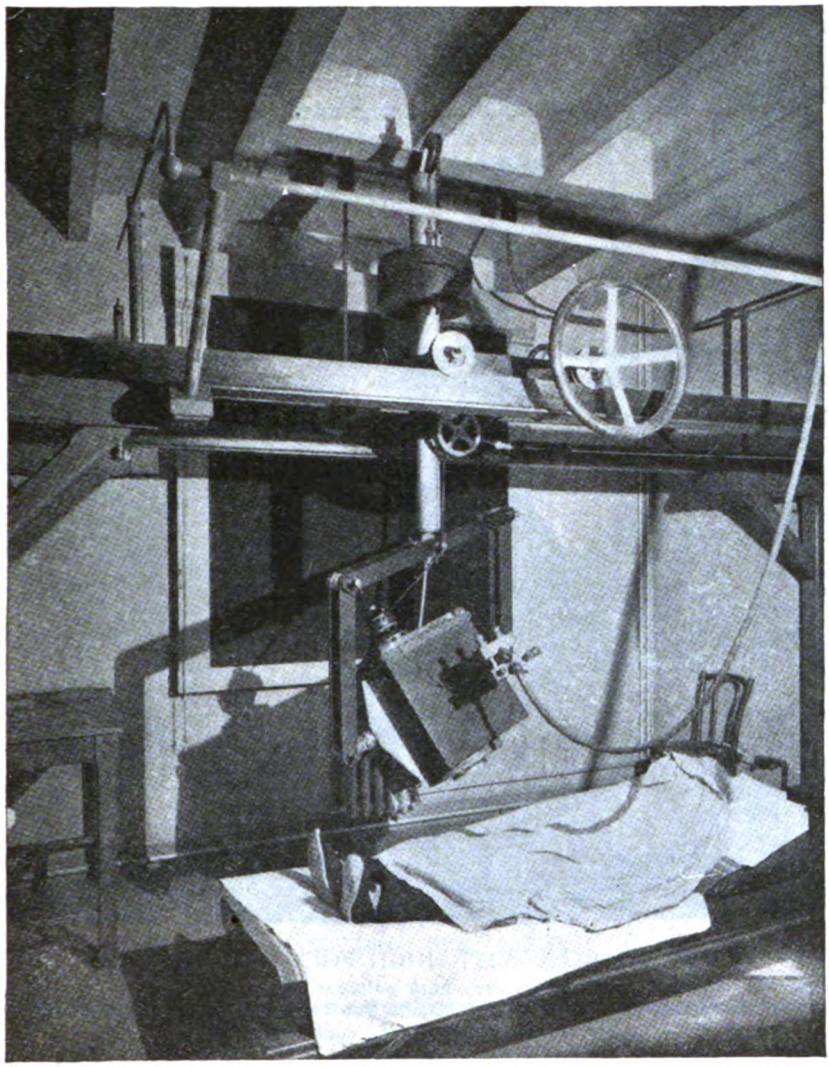

Boyer

HOW HIGH-VOLTAGE ELECTRICITY AIDS THE SICK

This apparatus, in the Institute of Radium in Paris, uses a potential of 100,000 to 250,000 volts to produce the extremely powerful X rays used in the treatment of cancer and other diseases.

ample, when the first thermometers were being constructed, it was believed that the highest temperature attainable was that of a charcoal fire and that the lowest degree of cold was that of a cold winter in the north of Europe. The zero point of the Fahrenheit scale was set at this lowest air temperature and it was thought that "below zero" temperatures were impossible.

But science has now made available to the laboratory worker temperatures tremendously beyond this range in both directions. Electric furnaces produce temperatures up to 5,500 or 6,000 degrees Fahrenheit, more than twice as hot as the hottest charcoal fire. And the development of liquid air, liquid hydrogen and liquid helium has given us low temperatures reaching to 455 de-

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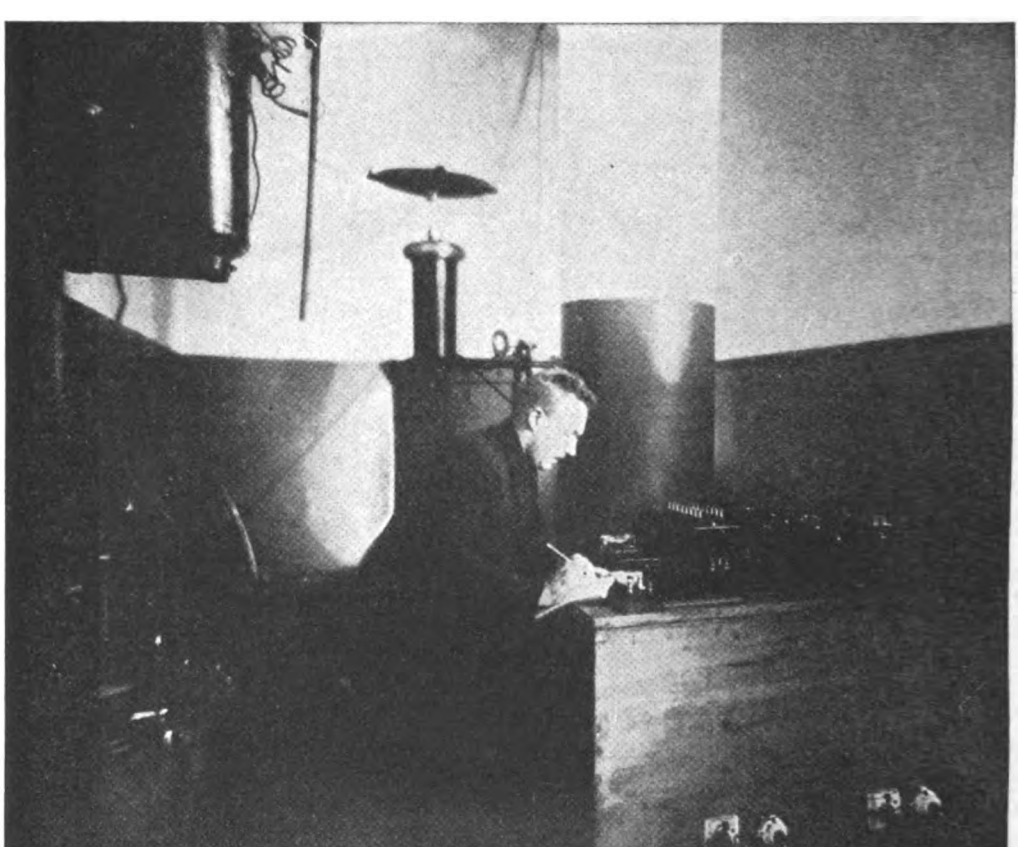

Habirshaw Electric Cable Co.

TESTING CABLES WITH HIGH-VOLTAGE CURRENTS

One of the main practical uses of very high voltages, at present, is in testing electric cables before they leave the factory. Possible faults in insulation can be discovered and corrected before the cable is laid.

grees below zero, Fahrenheit, within three or four degrees of the theoretical absolute zero of temperature at which all heat is supposed to disappear.

An instance of the importance of such extreme temperatures to science is the discovery that at the lowest degrees of cold the electric resistance of metals becomes almost nothing. If we could cool off a copper wire to the temperature of liquid helium and keep it from warming up again, we could send millions of kilowatts of electric power through it without burning it out and with only an infinitesimal loss of the electric energy. Of course, we cannot do this practically, at least not yet. But the facts about electric conductivity at very low temperatures have important bearings on the theories of electric conductivity in general and will result, we may be sure, in some kind of practical utility to electrical engineering.

The new high temperatures have been most useful also. Modern knowledge of alloys is largely due to high-temperature work, as is the knowledge that resulted in the discovery of ductile tungsten and the perfection of the tungsten filament for electric lamps and

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for radio vacuum tubes. If modern science had not had available to it temperatures hotter than the charcoal fire of the ancient alchemists there would be no tungsten wire nowadays and no radio.

The significance of all this for the possible utility of high-potential electricity is that these high voltages will permit us still further to extend the range of conditions that we can realize in the laboratory and to which we can expose materials in order to study their properties and behavior. For example, the highest temperatures ever attained on earth have been reached quite recently by sending a high-voltage electric discharge suddenly through a tiny metal wire. The wire, of course, burns up. In doing so it is supposed to reach, for an instant, a temperature in the neighborhood of 50,000 degrees Fahrenheit.

This is a higher temperature, even, than that of the surface of the sun. It probably does some very serious things to the constitution of the atoms of matter. Two Chicago scientists have announced, indeed, that by exploding in this way some very thin wires of tungsten they think that they have succeeded in decomposing some of the atoms of tungsten and transmuting them into other kinds of atoms, notably into atoms of helium. This experiment lacks confirmation by other workers but the result is by no means an impossible one. If the problem of artificial transmutation of the elements ever is solved, as we feel sure it soon will be, it is very likely to be accomplished in some such way as this, by the application of very high temperatures and very high voltages, in combination, to the atoms of matter.

It is believed, indeed, that exactly this sort of thing is going on all the time in the interior of the brighter stars. The temperature at the center of such stars probably exceeds a million degrees. The electric potentials may be equally tremendous. The ordinary earthly elements, astronomers believe, cannot exist under these conditions. Iron and gold and oxygen and all such elements will be decomposed into simpler ones. The spectroscope indicates that this is the case and it is probable that the scientists out at Pasadena will be proving it directly before long by duplicating here in an earthly laboratory the conditions which exist, we believe, off there millions of millions of miles away in the heart of a flaming star.

A distinguished scientist told me not long ago that there were, in his opinion,

Five Mysteries That High-voltage Electricity May Help to Solve—

1. What is the electron?
2. What is magnetism?
3. What is the origin of gravitation?
4. What is ether—the supposed medium that carries the electromagnetic waves of light and of radio?
5. What is it that enables living matter to keep alive and to reproduce itself?

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five fundamental scientific mysteries:

First was the mystery of what the electron is.

Second was the mystery of magnetism.

Third was the problem of the origin of gravitation.

Fourth was the great mystery of the ether, the question as to what it is that carries the electro-magnetic waves of light and of radio.

Fifth was the mystery of life, of how living matter is able to keep alive and reproduce itself.

The solution of any one of these mysteries might be of incalculable benefit to mankind and it is not likely that we will solve any of them by studying electrons or magnets or anything else under the ordinary conditions that exist on the surface of the earth. We must place our atoms and electrons and our living cells under *unusual* conditions. We must see what happens to them when they are 100,000 degrees hot, or when they are charged to a potential of three or four million volts. It is stress that brings out the qualities of atoms, as of people. Cook them, freeze them, compress them, electrify them, and we will find out what they are.

It is in investigations like these that we will find, I believe, the greatest value of our new 2,000,000-volt or 3,000,000-volt tool. It will help us to pry open the deep secrets of the universe.

But it may have some direct practical utility as well. There is already in service a 220,000-volt line for transmitting electric power. A 1,000,000-volt line is possible and may arrive before long. Mr. F. W. Peek, Jr., has calculated what such a line would have to be like. The towers would be 157 feet tall and the arms carrying the conductors would be nearly 50 feet from side to side. The conductors themselves would not be wires as in present transmission lines but would be hollow copper tubes 6½ inches in diameter. They would hang on a string of porcelain insulators more than fifteen feet long.

Such a line would carry 3,000,000 kilowatts a thousand miles with only 12 percent loss. No one is planning such a line now but it is only a few years since 200,000 volts was considered to be impossible and now it is a fact. A few years more and even a million volts may be a commonplace. And whether this happens or not, the use of these high voltages in laboratory work is very sure, I believe, to open to us some of the deepest secrets of Nature. Watch the news from Pasadena!

Kadel & Herbert

AN AMATEUR'S RECEIVER THAT SPANS THE CONTINENT

This set employs only one step of tuned radio-frequency amplification, but it enables its builder, Harold Herbert of New York, to listen in on California.

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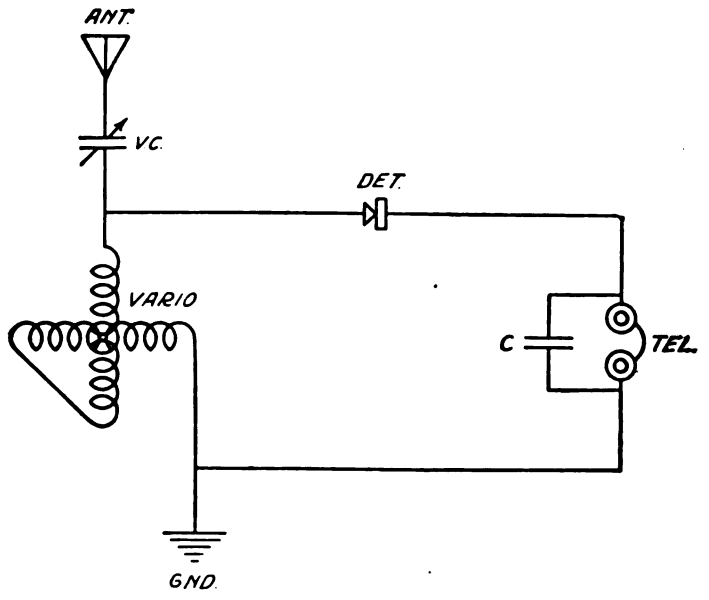

SINGLE-CIRCUIT CRYSTAL SET

Cost of parts: Not more than $18.00.
Selectivity: Fair.
Operation: Simple. The antenna circuit is tuned by both the condenser and the variometer. The closed circuit is controlled by the variometer.
Construction: Very simple to make.*
Approximate range: 15 miles.
Outstanding feature: A good, inexpensive set for the city dweller who is content to listen to local programs with the headphones.

*(*See* POPULAR RADIO, *December, 1922, page 292, for details of operation.)*

100 BEST HOOK-UPS

INSTALLMENT NO. 6

IN this series of hook-ups is being published—for the special benefit of the radio novice who is undecided as to just what circuit he wants—100 of the best radio receiving and amateur transmitting circuits, each thoroughly tested. The approximate ranges given here are averages based on actual records made with sets throughout the country. During the summer the actual ranges may fall to 50 percent of the value given, while in the winter, in the best of conditions, the actual ranges may exceed the values given by as much as 500 percent. All of these circuits have been described in previous issues of POPULAR RADIO.

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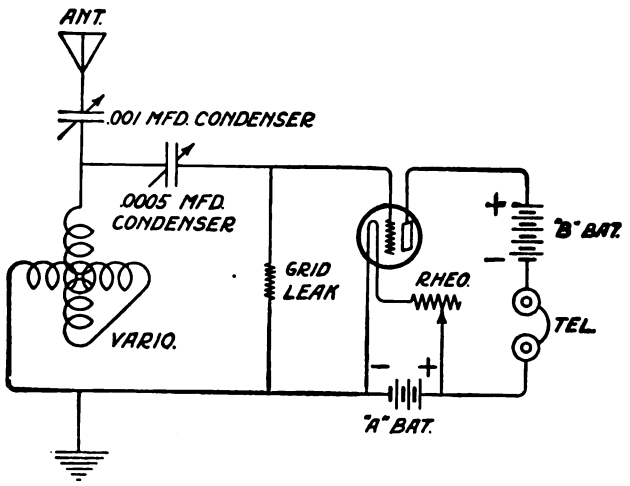
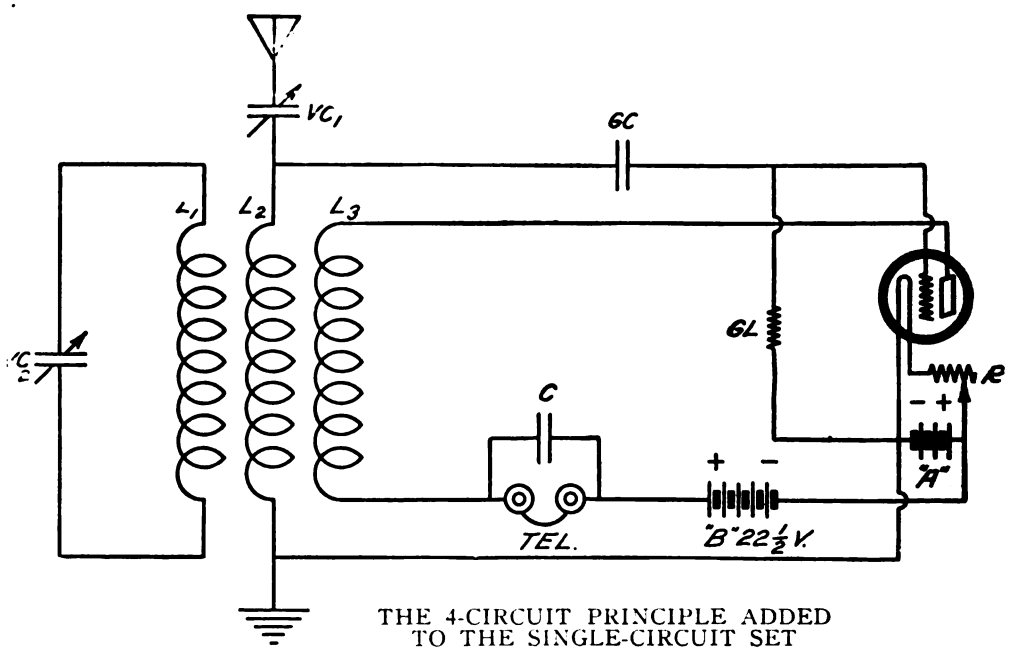


SINGLE-CIRCUIT NON-REGENERATIVE SET

Cost of parts: Not more than $22.00.
Selectivity: Only fair. (This modification is a little more selective than the one shown on page 50 of the January issue.)
Operation: Simple. The variometer and one of the variable condensers tune the antenna, and the variometer and the other variable condenser control the grid-circuit tuning.
Construction: Not complicated.*
Approximate range: 100 miles.
Outstanding feature: A non-re-radiating, single-circuit receiver for reception of local signals.

(See POPULAR RADIO, January, 1923, page 59, for constructional details.)



THE 4-CIRCUIT PRINCIPLE ADDED TO THE SINGLE-CIRCUIT SET

Cost of parts: Not more than $25.00.
Selectivity: Fair.
Operation: The extra circuit, comprising the condenser VC2 and the coil L1, gives a much better control of regeneration than in the conventional circuit.
Construction: Just an ordinary acquaintance with tools and some ability in wiring up the circuit is necessary.*
Approximate range: 500 miles.
Outstanding feature: The added circuit will give stability to the control of regeneration so that the circuit will not burst into oscillation and cause a violent disturbance in neighbors' receivers.

(See POPULAR RADIO, October, 1923, page 325, for constructional details.)

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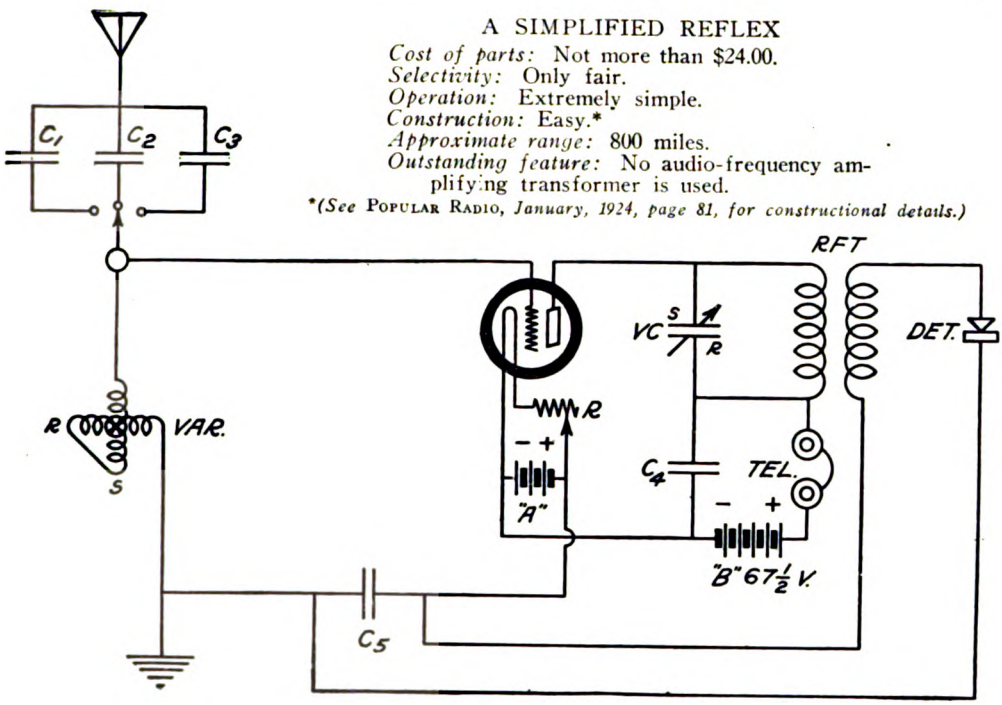
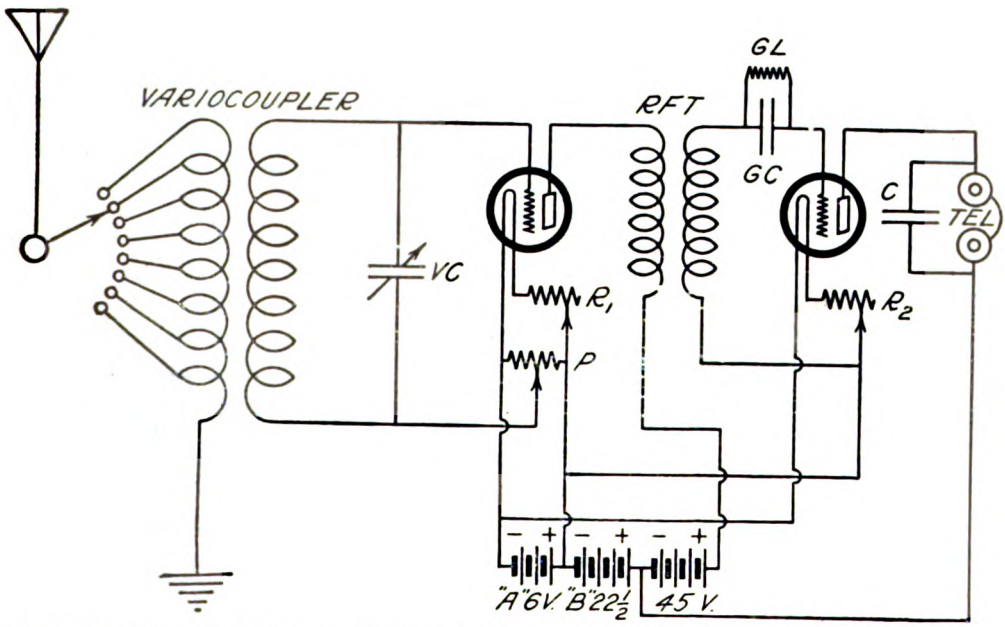
A SIMPLIFIED REFLEX

Cost of parts: Not more than $24.00.
Selectivity: Only fair.
Operation: Extremely simple.
Construction: Easy.*
Approximate range: 800 miles.
Outstanding feature: No audio-frequency amplifying transformer is used.

*(See POPULAR RADIO, *January, 1924, page 81, for constructional details.)*





ONE STAGE OF RADIO-FREQUENCY AMPLIFICATION ADDED TO A STRAIGHT AUDION CIRCUIT

Cost of parts: Not more than $28.00.
Selectivity: Good.
Operation: Not difficult.
Construction: Nothing especially complicated.*
Approximate range: 500 miles.
Outstanding feature: This is a good circuit for the man who already has a simple vacuum-tube circuit and wishes to make it more sensitive.

*(See POPULAR RADIO, *June, 1923, page 471, for constructional details.)*

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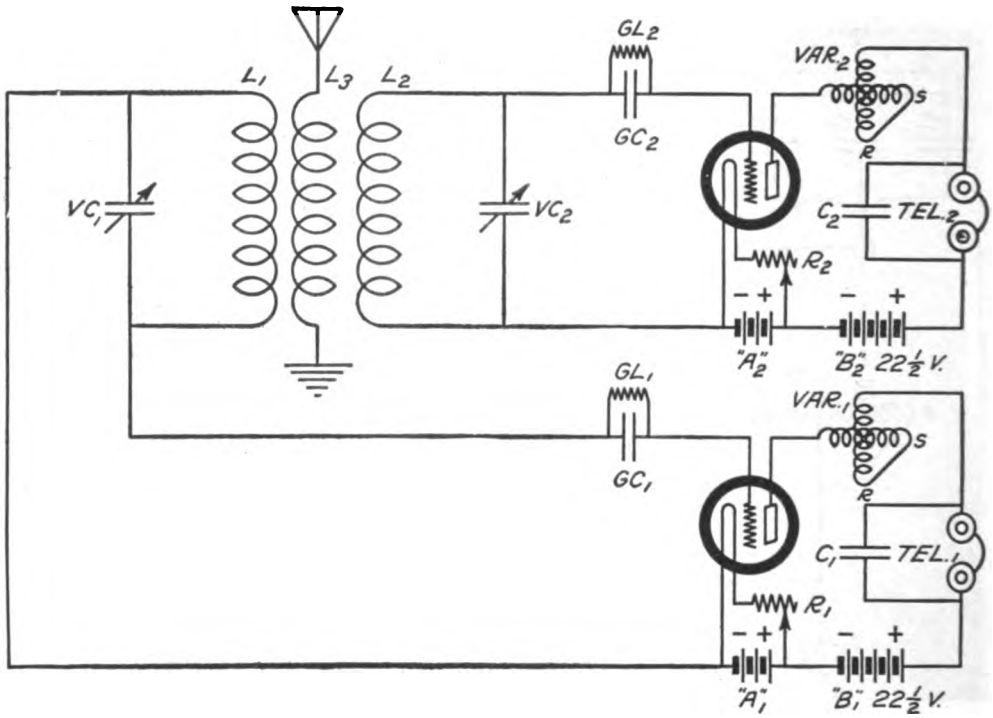
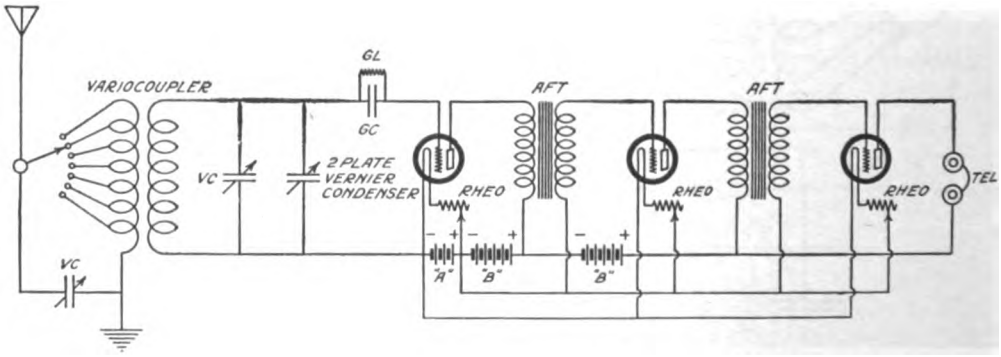


A DUPLEX REGENERATIVE RECEIVER

Cost of parts: Not more than $55.00.
Selectivity: Very good.
Operation: A few weeks' practice will suffice to enable efficient tuning of both parts of the set.
Construction: Just an ordinary acquaintance with tools and some ability in wiring up the circuit is necessary.*
Approximate range: 500 miles.
Outstanding features: Sharp tuning, and the fact that the set will bring in two programs (on different wavelengths) at the same time on two pairs of telephones.

*(See POPULAR RADIO, *January, 1924, page 96, for constructional details.)*



A SIMPLE AUDION CIRCUIT WITH TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $40.00.
Selectivity: Fairly good.
Operation: Easy to operate.
Construction: Simple.*
Approximate range: 300 miles.
Outstanding feature: The set will bring in any signals, with great clarity, as long as they are strong enough to operate the detector.

*(See POPULAR RADIO, *March, 1923, pages 232-233, for constructional details.)*

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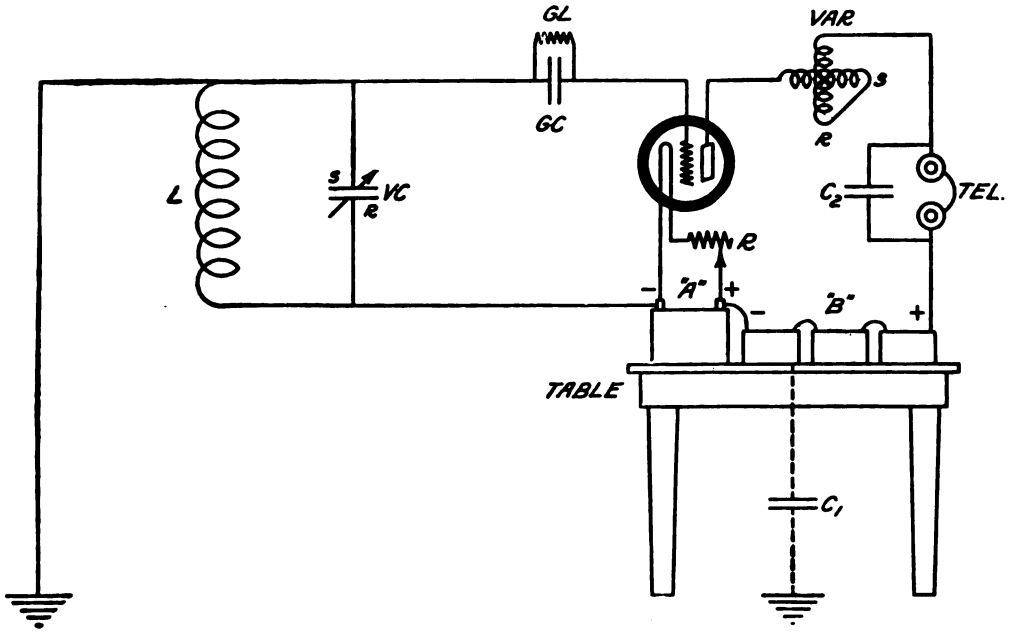
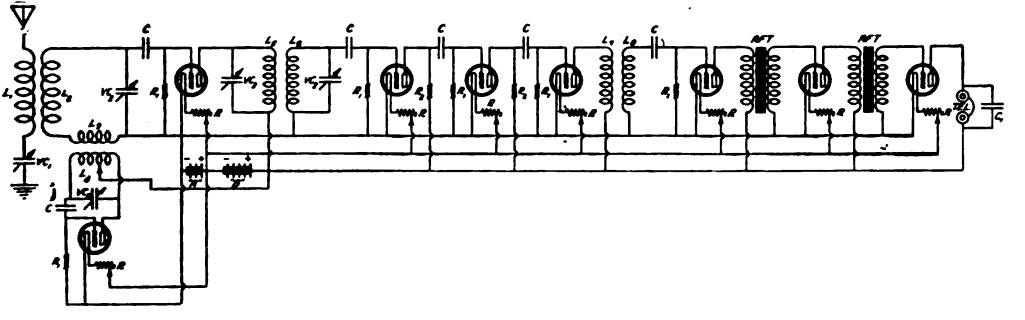


A REGENERATIVE SET FOR RECEPTION WITH A GROUND ONLY

Cost of parts: Not more than $23.00.
Selectivity: Excellent.
Operation: Easy to tune. There are only two controls, the variable condenser for wavelength, and the variometer for regeneration.
Construction: Very simple to make.*
Approximate range: 25 miles.
Outstanding feature: This is a good type of receiver for local reception where the conditions make impossible the erection of an outside antenna.

(See POPULAR RADIO, November, 1923, page 372, for details.)



A RESISTANCE-COUPLED SUPER-HETERODYNE WITH TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $80.00.
Selectivity: Excellent.
Operation: Difficult.
Construction: A very complicated circuit to master.*
Approximate range: 3,000 miles.
Outstanding feature: This set combines sensitivity with great selectivity.

(See POPULAR RADIO, June, 1923, pages 468-469, for constructional details.)

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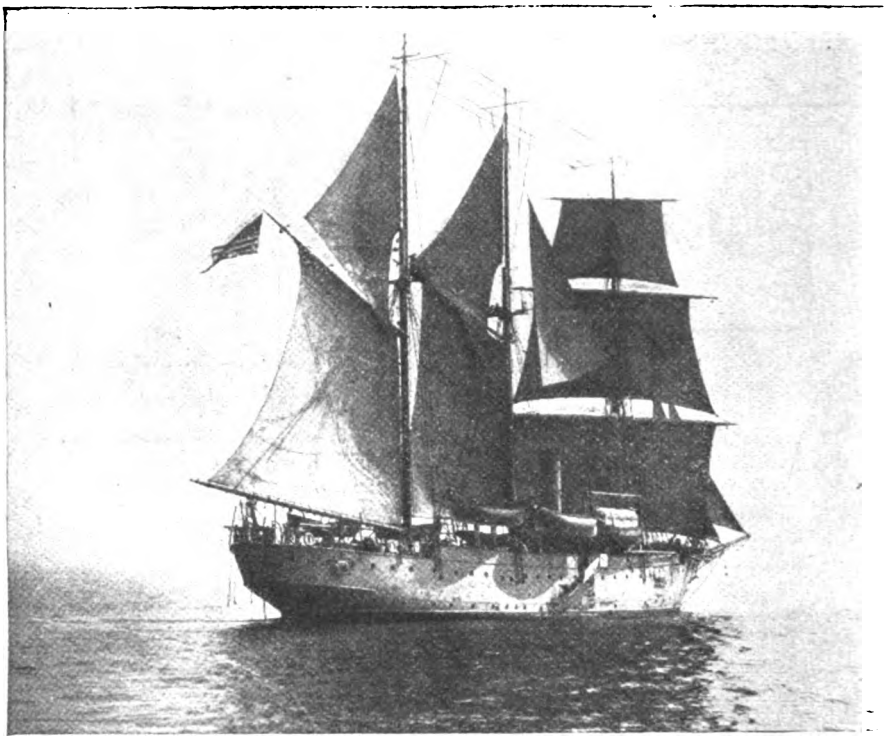

International

HER ANTENNA PROVED TO BE A LIFE-LINE

The NEWPORT, *schoolship of the New York State Nautical Training School, kept in such close communication with the broadcast weather reports that she was just able to keep outside the fringe of a tropical hurricane.*

How Radio Saved a Sailing Ship

A true adventure of the only large vessel of its kind that is equipped with receiving apparatus.

By ARMSTRONG PERRY

THE only sailing ship in the world equipped with radio is probably the *Newport*, the schoolship of the New York State Nautical Training School. And last summer when the *Newport* made her practice cruise across the Atlantic and back she was altogether a sailing ship, for her auxiliary steam plant was out of commission.

Nevertheless, Mr. Albert Bombe, who sailed with her as radio operator, kept his radio in commission with the help of storage batteries and other expedients. Not many voyages in recent years have necessitated so much ingenuity in adapting radio to unusual conditions. And in few voyages, if any, has radio rendered so vital a practical service to the ship. On her return trip the *Newport* encountered the fringe of a tropical hurricane. She had no steam power with which to run away and it might have gone ill with her had she experienced the full force of the storm.

But Mr. Bombe's radio was able to pick up frequent bulletins of the storm's

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progress and the captain was able to use this information in dodging the danger.

The use of radio on a sailing ship involves many unusual conditions. The wires cannot be protected from the wear and tear by men and gear, as they can on a steamship. Operator Bombe's first two days aboard were occupied entirely in repairing defective insulation and in removing short circuits where accidents due to these causes had damaged the wiring.

Then when he was ready to open up with his transmitter, he discovered that the officers were using the lead-in as a clothes line because it happened to run through their quarters. This interfered with both transmission and reception.

One day an engineer touched the lead-in while the transmitter was working and was severely burned. Another day a leaky spark-gap nearly burned up the whole set.

Besides being responsible for the radio work, Bombe issued a daily newspaper filled with items caught from the air. He also served as librarian and general consulting scientist. When the navigator observed, one day, an unusual deflection of the compass, Bombe showed him a passage in a Life of Columbus stating that the discoverer of America had noted a similar phenomenon when his ships were in approximately the same position in the ocean.

The *Newport* touched at only one port in Europe, Teneriffe in the Canary Islands, then she started homeward. While nearing the American coast, Bombe picked up the hurricane warning.

The storm was headed up from the Bahamas. The captain knew that all he could do was to play a dodging game. For a week it was up to Operator Bombe to get news, somehow, of the progress of the storm and of weather conditions in other quarters. One error in copying latitude or longitude might mean shipwreck.

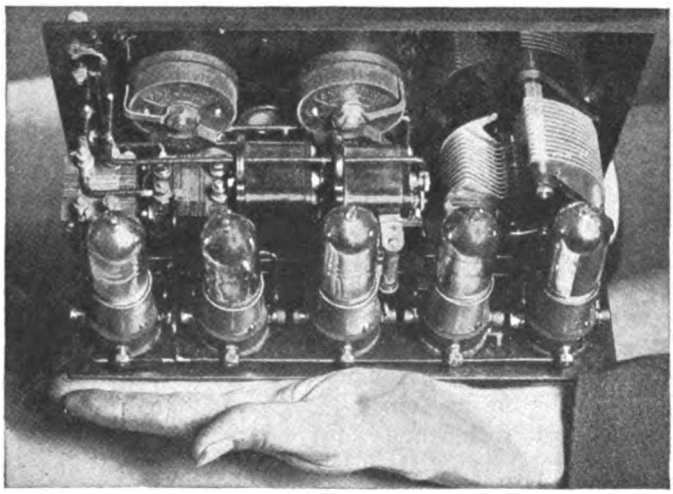
The static was terrific and Bombe had great difficulty in copying the warnings. Sometimes the ship had to run far off her course in order to escape an extension of the tempest. Sometimes she set all sails and trusted to speed and luck in crossing the path of a storm she could not avoid.

Good navigation and good fortune—plus radio—brought the schoolship home eventually, undamaged and with all hands in good health and spirits.

The ocean graveyard that received so many luckless sailing ships in the old days when there was no radio, had been cheated for once.

THE SMALLEST 5-TUBE SET IN THE WORLD?

Its maker, Sidney Kasindorf of New York, thinks that it is. It consists of two stages of radio frequency, detector and two stages of audio frequency, and operates a loudspeaker on a small loop antenna.



Kadel and Herbert

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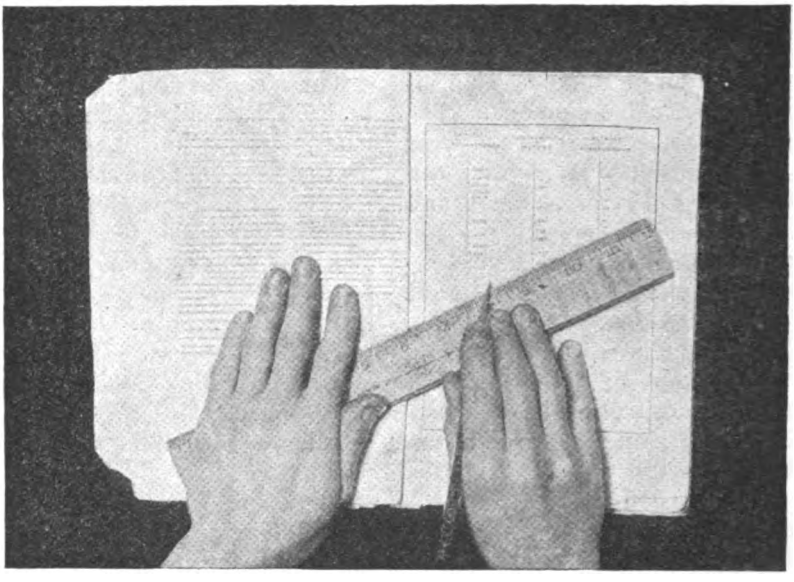

These are all the tools
you will need—

By means of a ruler and a pencil and the table on the opposite page the amateur who builds his own apparatus may calculate in an instant the design for a rheostat that will have a pre-determined resistance, or find out the resistance of a rheostat that is already built.

A MEASUREMENT CHART

FOR USE IN DESIGNING A RHEOSTAT

ARTICLE NO. 8

The previous articles contain charts *For Determining the Constants of Radio Circuits and Calculating Capacities of Condensers in Series*, in February, 1923; *For Determining the Dimensions of Your Coil*, in March, 1923; *For Determining the Capacity of a Condenser*, in May, 1923; *For Determining the Capacity of Your Antenna*, in July, 1923, and *For Determining the Constants of a Loop Antenna*, in August, 1923; *For Use in Designing a Transformer*, in March, 1924; *For Determining the Maximum Capacity of a Variable Condenser*, in April, 1924.

By RAOUL J. HOFFMAN, A.M.E.

MATERIALS used for transmission and distribution of electric energy are conductors, which have a certain resistance. This resistance is measured in ohms. The resistance of a wire is inversely proportional to the cross-section of the wire; that is, the thinner the wire, the higher is the resistance.

The standard thicknesses for wires, in electrical engineering, follows the B. & S. wire gauge and most handbooks have reference tables for the resistance of a standard length of wire.

Copper has almost the lowest resistance of any of the conductive materials. Assuming the resistance for copper as a unit, we can find the resistance for various materials by multiplying the resistance of copper by the following figures, if the same length and thickness is taken.

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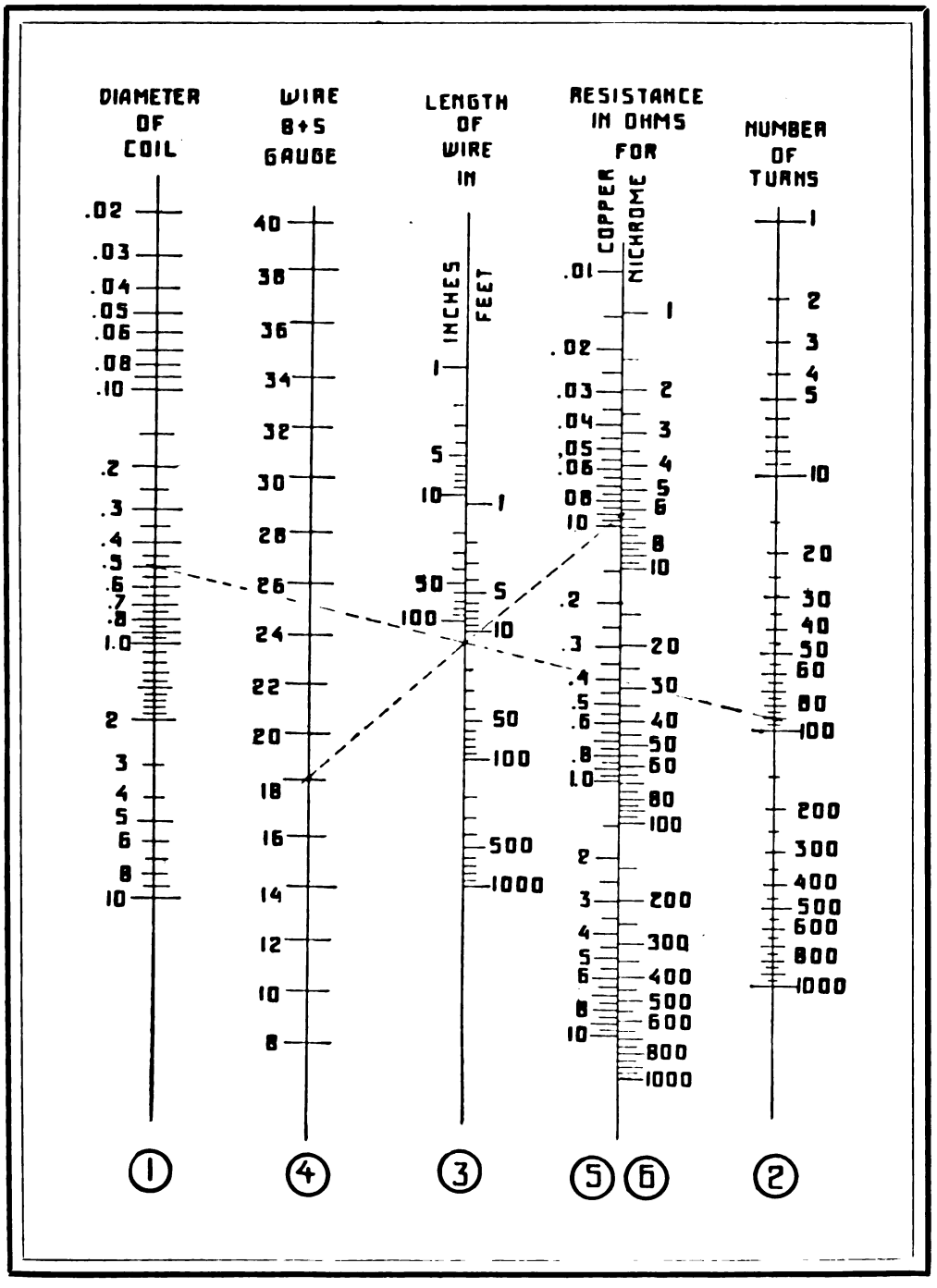

HOW THE RESISTANCE CHART IS USED

You must first determine the diameter of the coil upon which you are to wind the resistance wire. Then you should decide what size of wire you want to use. The chart will give you the resistance of the wire and the number of turns you should wind on to get any specified resistance. The article tells you how to do it.

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Silver	by	.94
Copper	"	1.00
Aluminum	"	1.7
German Silver	by about	20
Monel Metal	by	26
Mercury (quicksilver)	"	53
Nichrome Alloy	"	68

A rheostat is a device for controlling the resistance of a circuit. The rheostat plays a large role in most electrical circuits; especially in radio work. For standard material German silver or nichrome wire is used and wound into the shape of a coil.

The method of calculating the resistance of a rheostat is simplified by the use of the chart illustrated on the preceding page.

To find the resistance of a No. 18 wire, 12 feet long, connect 18 on scale No. 4 with 12 on scale No. 3 and read. for copper, on scale No. 5. The result is .09 ohms. For nichrome, on scale No. 6. the result would be 6.2 ohms.

To calculate the resistance of a coil rheostat half an inch in diameter, having 90 turns, made of No. 18 B. & S. nichrome wire, connect .5 on scale No. 1 with 90 on scale No. 2 intersecting the reference line on scale No. 3, giving a total length of 12 feet.

Then connect the intersecting point on scale No. 3 with 18 on scale No. 4 and read the resulting resistance of 6.2 ohms on scale No. 6.

This table will help you greatly in the design of special rheostats of various resistances.

Internat onal

A RADIO FIRST-AID STATION ON SKIIS

In the winter sports regions of Germany, where accidents sometimes occur and the services of a doctor are required, a novel radio equipment has been devised for summoning aid. The apparatus consists (as shown above) of a miniature receiving and sending set that is attached to the person of the doctor.

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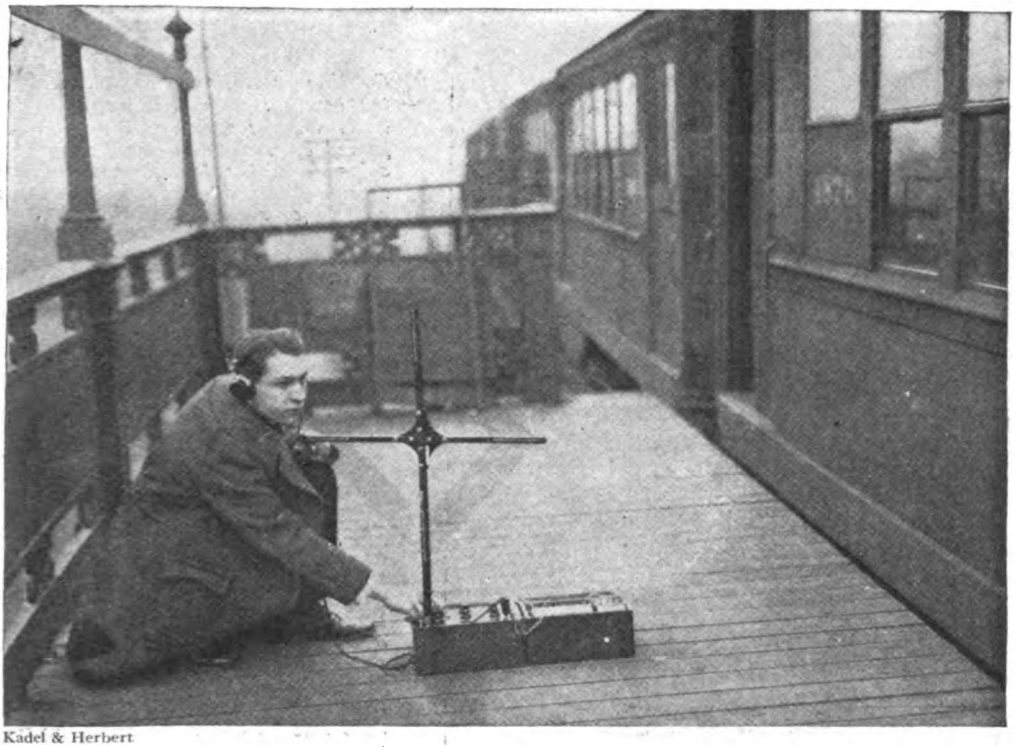

Kadel & Herbert

INTERFERENCE FROM BRUSHES ON ELECTRIC TRAINS

The brushes on the elevated trains produce sparking which really is very troublesome. This sparking will make your loudspeaker respond with a ripping sound something like static each time a train starts up.

Where Interference Comes From

Radio amateurs who live in the suburbs of a city are troubled by a peculiar kind of interference in receiving. This trouble manifests itself in a loud, scratchy, humming sound which drowns out reception and lasts for periods ranging from two or three seconds to several minutes continuously, several times each evening. One of these amateurs, Sidney Kasindorf of the Bronx, New York, started out with a portable receiver with a directional loop antenna and tried to track the interference to its lair. The pictures shown here illustrate some of the causes for interference which are likely to bother receiving.

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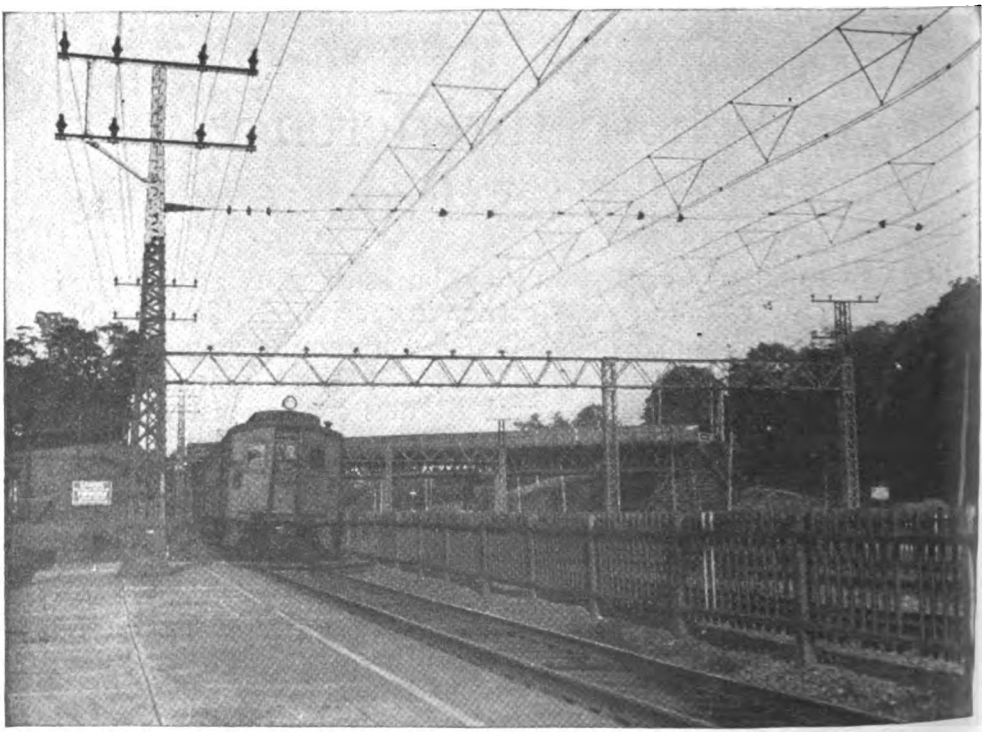
INTERFERENCE FROM MAIN POWER SWITCHES

Opening or closing a giant switch at the power station will also cause a radio impulse which will be accompanied by a simultaneous "crack" issuing from the loudspeakers of the receiving sets situated within a block or so of the station.

INTERFERENCE FROM HIGH-TENSION LINES

The worst interference was found to emanate from the railroad high-tension lines. It is not definitely known whether this is caused by leakage on the lines or by an oil switch, opening and arcing, or whether it is caused by passing trains whose power is derived from the overhead trolley system. When all of the various causes have been tracked down the amateurs will attempt to have the unconsciously offending interests co-operate with them to eliminate the trouble.



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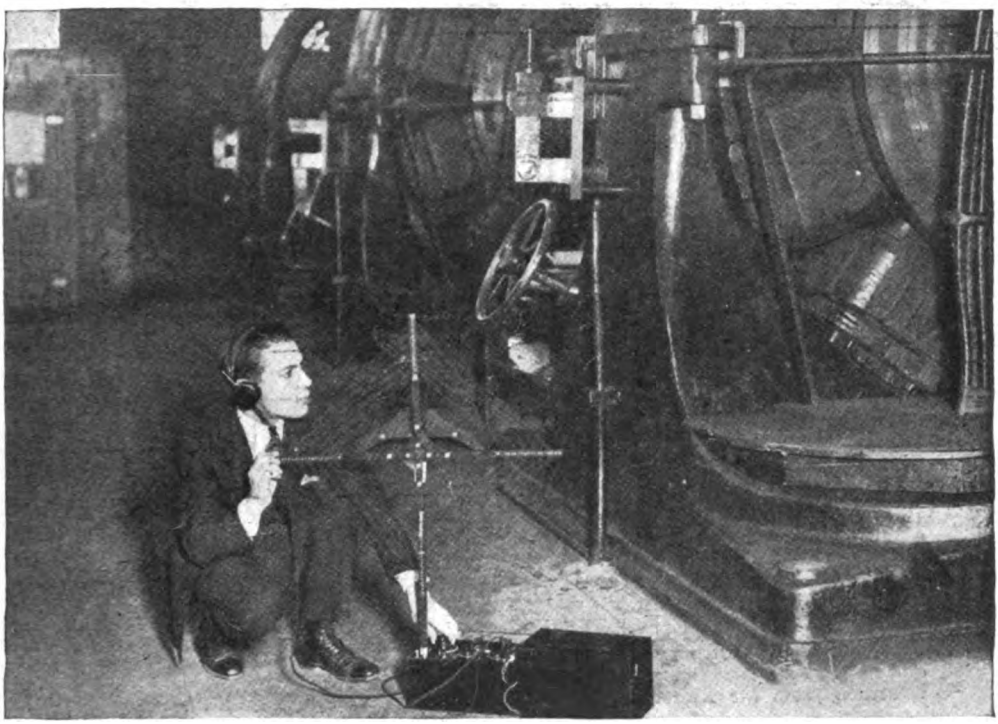
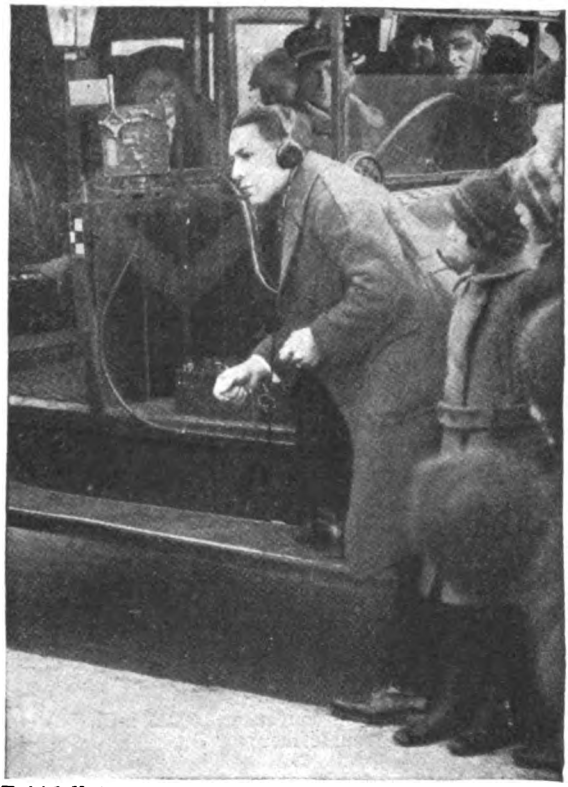


Kadel & Herbert

INTERFERENCE FROM LARGE GENERATORS

The sparking at the commutators on the large D.C. generators or the rotary converters in a power house or substation cause another kind of interference which will tend to spoil reception in the immediate vicinity of the power house.



Kadel & Herbert

INTERFERENCE FROM AUTOMOBILES

The ignition of automobiles sends out feeble impulses which can be heard in the telephones of an ultra-sensitive receiver in the form of a series of clicks. Of course, the wavelength of these impulses is extremely short and they would not affect an ordinary receiver.

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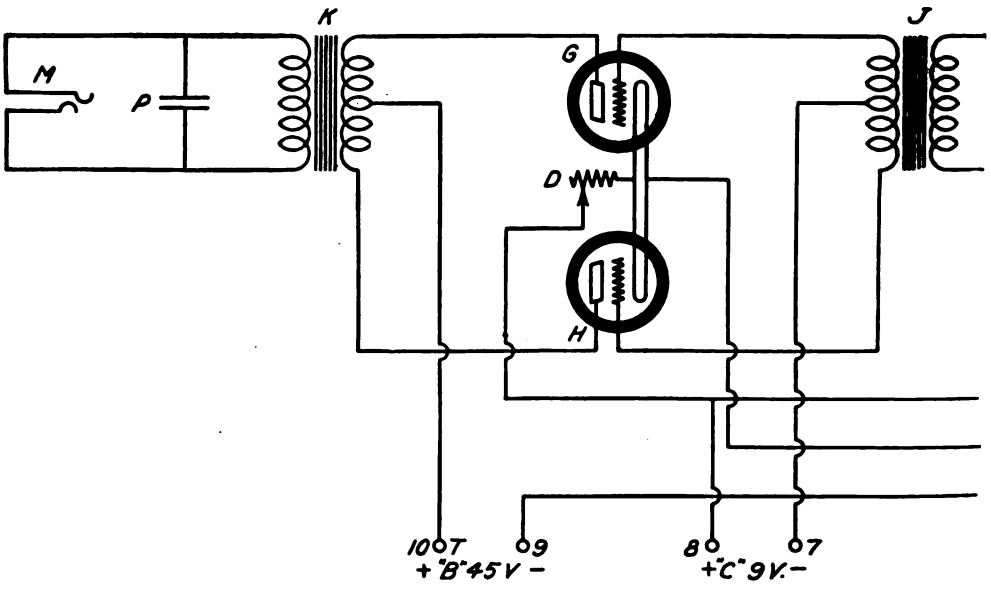

THE ELECTRICAL WIRING DIAGRAM

FIGURE 1: *This drawing shows the correct way to hook up the various instruments and parts in the circuit so that they will function properly. Notice that the diagram is drawn from the* RIGHT *to the* LEFT, *so that the wiring is shown exactly as it goes into the amplifier.*

HOW TO MAKE AN AUDIO-FREQUENCY AMPLIFIER —THAT DOES NOT DISTORT

This article is of value to every user of a radio set—because it describes a newly developed type of amplifier that is entirely unmarred by distortion. It may be built by anyone who has only the ordinary proficiency with tools.

By LAURENCE M. COCKADAY, R. E.

COSTS OF PARTS: *About $45.00*

HERE ARE THE ITEMS YOU WILL NEED—

A—Bradley-Ohm No. 25 (25,000 to 250,000 ohms);
B—Bradley-leak, ¼ to 10 megohms;
C and D—Amsco rheostats, 20 ohms;
E, F, G and H—Naald standard vacuum-tube sockets, No. 400;
I—Amertran transformer, 5 to 1 ratio;
J—Como "input" transformer;
K—Como "output" transformer;
L—Martin-Copeland jack, double-circuit;
M—Martin-Copeland jack, single-circuit;
N—Dubilier mica fixed condenser, .00025 mfd. with clip for transformer;
O—Dubilier mica fixed condensers, .005 mfd. plain (three used in parallel);
P—Dubilier mica fixed condensers, .005 mfd. plain (three used in parallel);
Q—composition panel;
R—Quinby radio frames 7 by 8 inches;
S—cabinet;
T—EBY binding posts;
U—connection block;
V—Celatsite (insulated connecting wire); solder, screws, etc.

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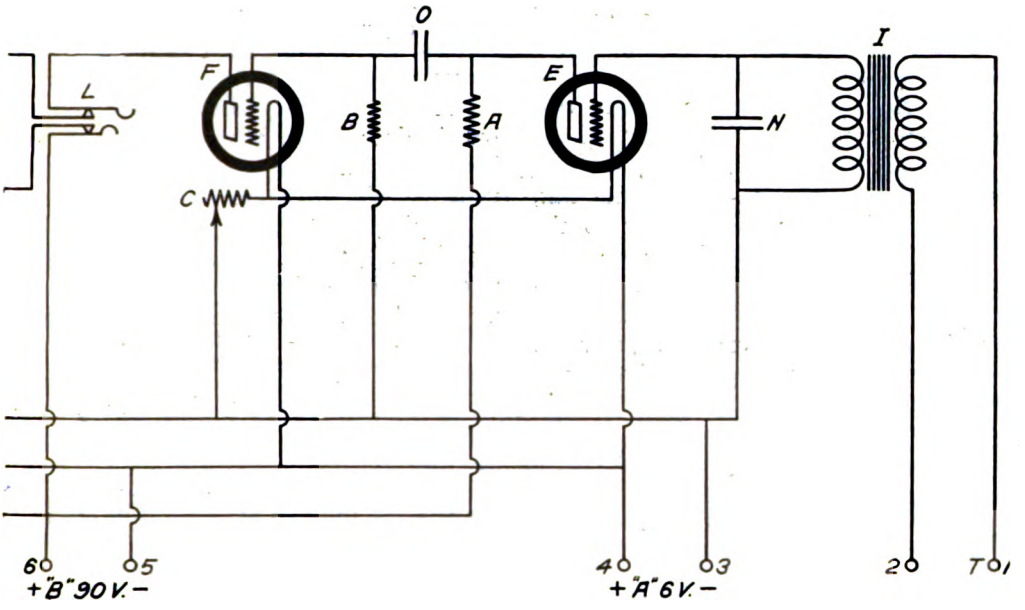

THERE is no doubt that radio reception, in its most popular form, the reception of radio broadcasting, depends to a great extent upon some form of loudspeaker for its popularity.

The loudspeaker that is used to reproduce the broadcast entertainment must be a good instrument; so that the programs will have real life, they should not give a thin, squeaky, dim or distorted reproduction. Most of the new loudspeakers now on the market are good.

There are, however, many other problems that must be considered in insuring good clear broadcast reception. First of all, there is the matter of the transmitting apparatus. The microphone that picks up the broadcasting in the studio must convert the sound waves of the voice and music without distortion. The modulation system of the transmitter must not introduce any noticeable distortion. These problems apply to the transmitting station, and most of the larger broadcasting stations now have modulation systems in which the broadcast material is transmitted with a good to excellent degree of clarity. There are other considerations, however, that apply directly to your own receiving apparatus!

In some of the more simple regenerative receivers there is a possibility of obnoxious distortion in the detector circuit itself.

In the single-circuit regenerative receivers this over-regeneration causes distortion not only in the owner's set, but in the other sets in the neighborhood that receive on the same wavelength.

For clear and enjoyable reproduction in a loudspeaker, then, there must be *no distortion in the detector circuit.*

And here we come to the amplifier!

The amplifier is the last piece of apparatus between the microphone at the transmitting station and the loudspeaker at the receiving station. We must have a good amplifier before we may be sure of the consistently good reception that is to make radio broadcasting really popular in the home.

The amplifier that is commonly used is ordinarily built up of two stages of transformer-coupled amplification which amplify at an audible frequency. Now it is an almost impossible feat of engineering to get a two-stage transformer-coupled amplifier that will give maximum signal amplification and still retain the best quality of reproduction. Even if we design a

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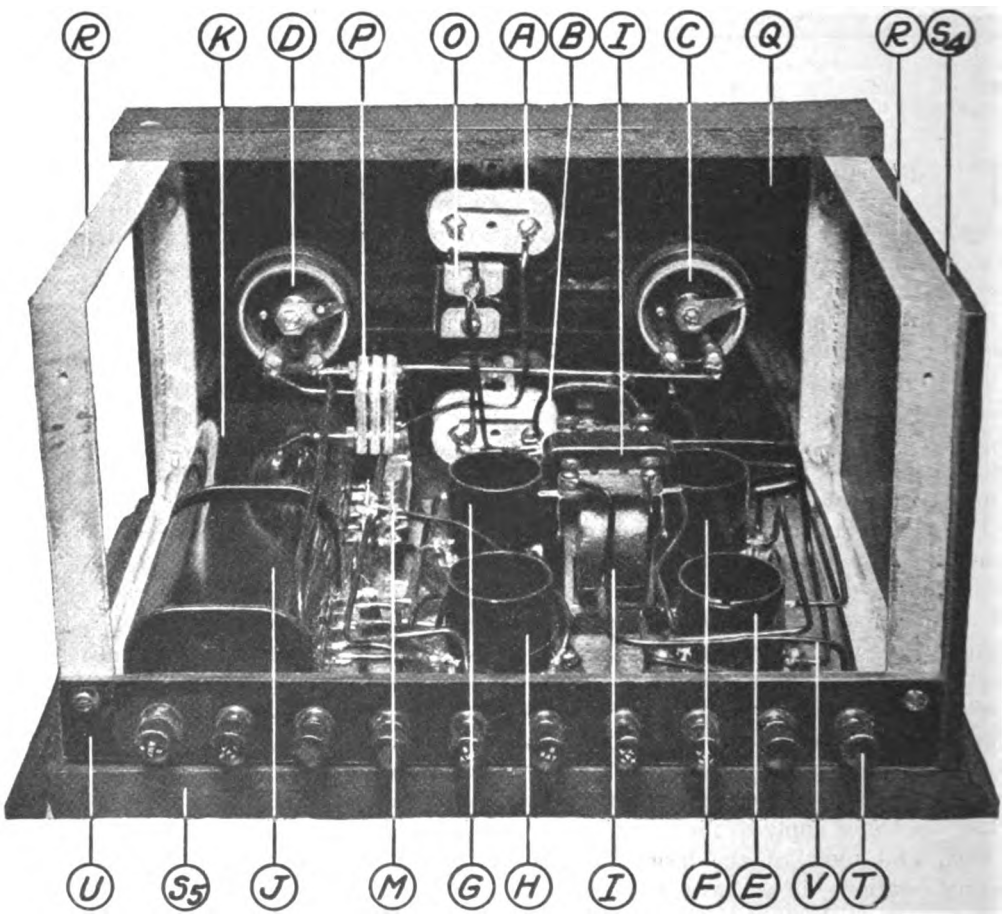
transformer that with a specified type of tube will give equal amplification over frequencies between 200 and 3,500 or 4,000 cycles, yet when we couple two such stages together with more voltage on the plate of the second stage we encounter trouble from a sort of feed-back, and some distortion that is due to the magnetic condition of the iron core upon which the transformer is wound. Therefore, we have to "dope" such an amplifier with resistances or capacities, or both, connected in different parts of the circuit, to eliminate this trouble at least in part. And even then, we do it only at a considerable loss in over-all volume.

This does not mean, in a well-designed amplifier of this type, that it is impossible to get satisfactory results, but it does mean that in most of the home-built amplifiers the construction usually calls for two audio-frequency amplifying transformers (good, bad, or indifferent), two rheostats, two tubes and a couple of jacks wired up to "make a noise." And that is why some people who listen to one of these for the first time observe:

"Well if this is radio, give me a phonograph."



VIEW OF THE AMPLIFIER, FROM THE REAR

FIGURE 2: *This photograph shows clearly, the arrangement of the parts mounted directly on the panel, as well as the parts mounted on the base of the amplifier. The parts are all designated by letters that reappear in the text, the diagrams and the list of parts.*

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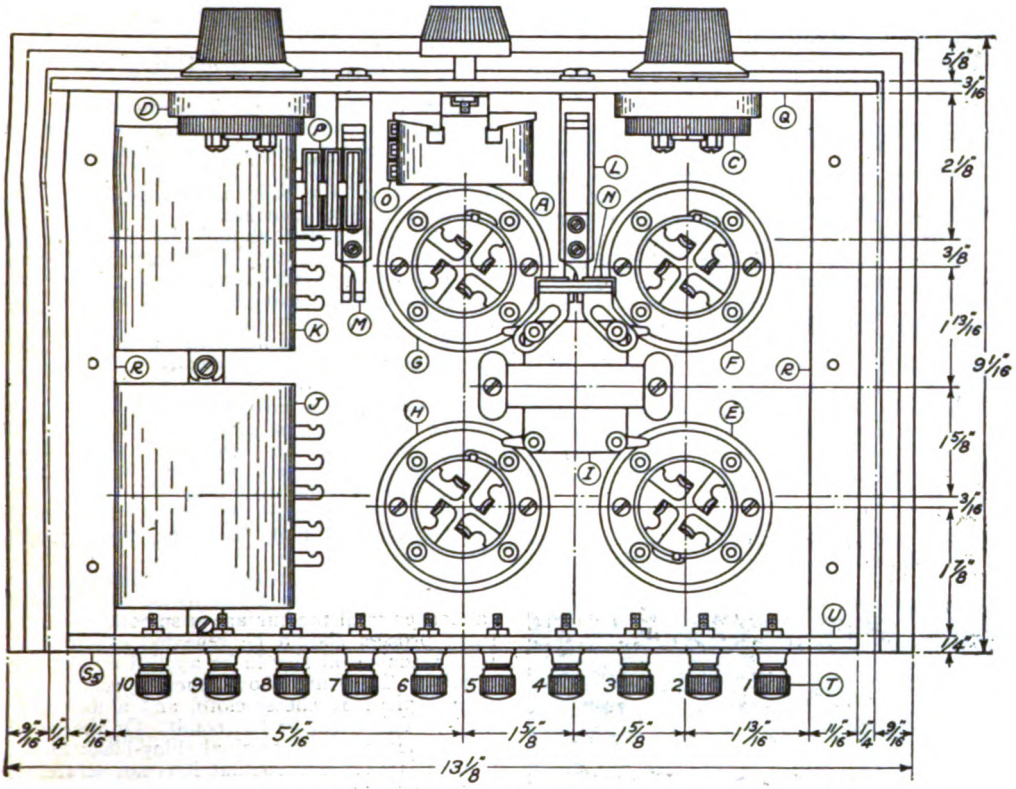

THE WORKING DRAWING FOR CONSTRUCTING THE AMPLIFIER

FIGURE 3: *Here are shown the exact positions for the instruments. The positions are given, center to center, for all instruments. Note that the binding posts are mounted on a composition strip, which is screwed to the aluminum frames.*

The amplifier that is described in this article consists of three stages:

First stage; transformer coupled
Second stage; resistance coupled
Third stage; push-and-pull, transformer coupled.

The transformer in the first stage operates from the plate current of the detector tube, which is small; therefore, the distortion due to core saturation is not present.

The second stage uses a higher plate voltage; therefore, instead of being coupled by a transformer it is coupled through a new variable resistance which can be set at the correct value for the tubes used. This type of amplification is practically distortionless.

For the third stage is used the push-and-pull method of connecting two tubes in the circuit, with a split-winding input transformer and a split-winding output transformer so that the two tubes work in a manner, analogous to the steam engine; one tube (piston) pushes while the other tube (piston) pulls. In this system the output-transformer core is only energized by the signal variations and the normal plate currents of the two tubes cancel out and do not produce any core magnetization.

These three methods of coupling between stages used in combination produce a great volume of sound, still they retain the clarity and truthfulness of the original sound as spoken, sung, or played into the microphone.

This amplifier can be connected to *any* single-tube set and will be applicable to *any* multi-tube radio-frequency set. It

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should be connected direct to the plate circuit of the detector.

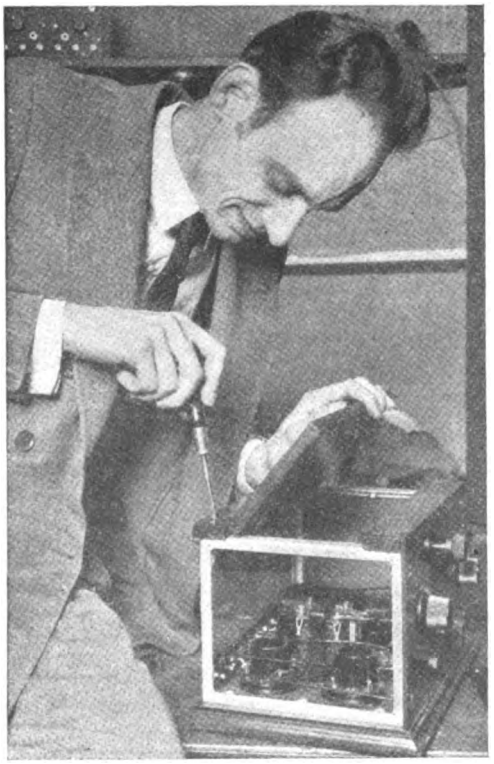
The electrical wiring diagram is shown in Figure 1.

The Parts Used in Building the Amplifier.

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of the amplifier may easily determine how to mount the instruments in the correct places and connect them properly in the electric circuit. The same designating letters are used in the text and in the list of parts at the beginning of the article.

¶ *The list of parts there given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel for mounting them.



ASSEMBLING THE CABINET

FIGURE 4: *This picture shows how the wooden strips that form the cabinet are fastened to the frames with machine screws. They can be attached in a few minutes with no other tools than a screw-driver.*

How to Construct the Amplifier

After procuring all the instruments and materials for building the amplifier the amateur should set about preparing the panel (shown in Figures 2, 3, 5, 6, 7 and 10).

First of all the panel should be cut to the correct size, 7 x 12 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 5.

The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next, the two rheostats, C and D, should be fastened to the panel Q, in their respective places by two screws each as shown in Figures 2, 3, 6, 7 and 10, and the small knobs and shafts affixed.

Then the coupling resistor A, should be mounted on the panel with the leak B, mounted below it. These two instruments are clearly shown in Figures 2, 3 and 10; they are mounted by unscrewing the shaft and knob, which is then inserted through the panel and then the rest of the instrument is screwed to the panel by two screws.

Now fasten the two jacks, L at the left (looking from the front) and M at the right-hand side. (See Figure 10.)

This completes the work on the panel itself.

The next job is to mount the panel on the two frames R. This is easily done with four machine screws inserted through the panel into the threaded holes provided in the frames. When this is done, attach the panel and the frames to the base in the same manner, with machine screws inserted up through the base into the four drilled and tapped holes that will be found in the bottom edge of the frames. The holes drilled in the base should be countersunk and a brass washer placed underneath the screw-head. This eliminates the possibility of the screws marring the surface of the table it is set upon. The brass washers prevent the wood from breaking out where it is weakened by countersinking.

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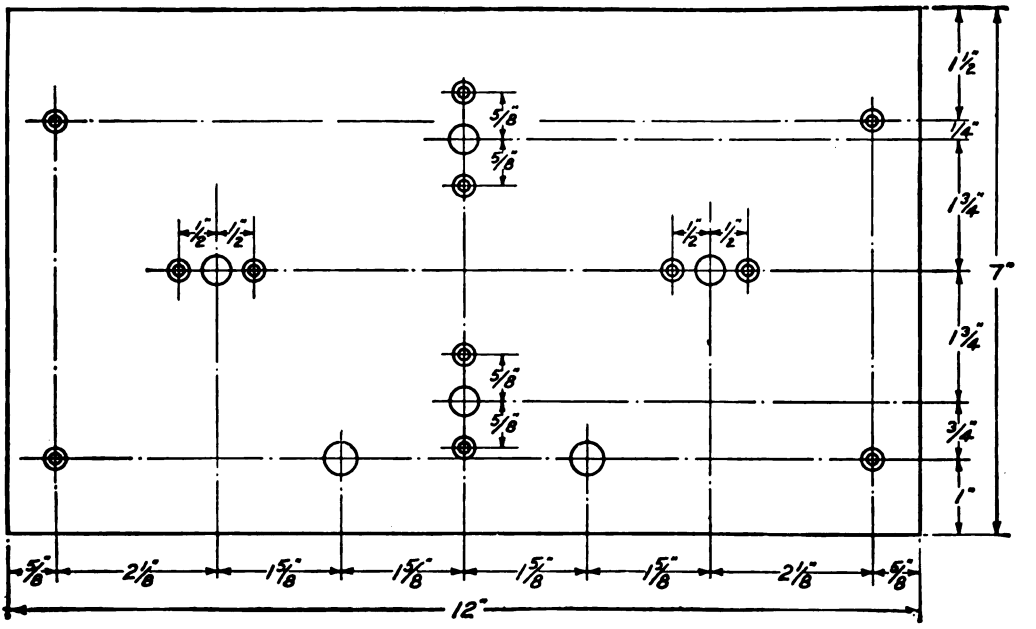

THE DRILLING PLAN FOR THE PANEL

FIGURE 5: *This drawing shows where to drill the holes for mounting the instruments. The correct spacings are given for the holes. The holes outlined with a double circle should be countersunk so that the heads of the screws will be flush with the surface of the panel.*

Now mount the rest of the parts on the wooden base S itself. Refer to Figure 3 for this and mount the four tube sockets E, F, G and H with brass wood screws. Then fasten down the transformer I, with two wood screws, and the transformers J and K, with three wood screws between them. The two adjacent feet of these transformers are held with a single screw.

The fixed condensers N, O and P are not fastened mechanically but are supported by the wiring and may be left until that work is being done.

Next, cut the connection block U out of composition panel according to the size given in Figure 9. This should be drilled for the ten binding posts and for the two screws that are used to fasten it to the back edges of the two frames R.

After the block is completed, attach the ten binding posts and cut off the screws of the three left-hand posts close to the inside surface of the panel, looking from the rear.

This will prevent shorting of the wires that are attached to the inside end of the posts, against the metal frame of the transformer J.

After the block U has been attached to the frames, you are ready to start the wiring.

How to Wire the Amplifier

In the design of this amplifier, care has been taken that there should be little or no interaction between stages, as this would cause an objectionable whistle. However, the builder of this amplifier may be sure that if the *specified* parts are used and put together as *specified*, the results will be as *specified*.

In wiring the set a type of bus-wire already covered with insulation was used and this saved a lot of labor. Just cut the wire to the correct length, bend it into shape, and scrape the ends and solder in place.

Carefully study out from the diagram in Figure 1, just what way would be the shortest way to run each wire, and do the least accessible wiring *first*.

Wire up the filament circuits first including the two rheostats, and the proper binding posts as shown by the numbers, 3 and 4 in Figure 1, and including the connections to one side of the grid-leak B, the positive "C" battery terminal No. 8 and the negative "B" battery post No. 5. Also finish the connections to the filament terminals on the sockets.

Next, connect up the input terminals P and B+ of the transformer I to the binding posts Nos. 1 and 2. Then finish the secondary circuit of this transformer including the condenser, N, the grid connection to the first tube socket E and the connection to the negative "A" binding post No. 3.

Now wire up the plate circuit of the first tube including the plate terminal of the first tube socket E, the resistor A, the condenser O, the remaining terminal of the grid-leak B, and the grid terminal of the second tube socket F.

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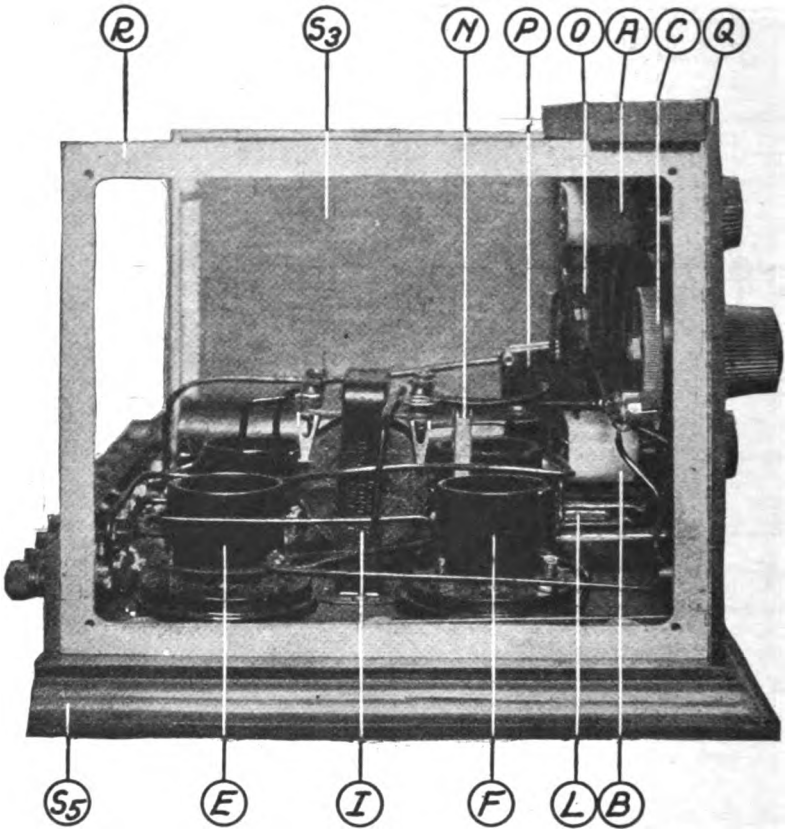

VIEW OF THE AMPLIFIER, AS SEEN FROM THE LEFT

FIGURE 6: *This picture shows how to mount the tube sockets and the transformer and gives a better idea of the way the frames are attached to both the wooden base and the panel.*

Then connect up the plate circuit of the second tube including the jack L, the plate terminal of the second tube socket F, the connections to the primary terminals of the transformer J and the connection to the binding posts Nos. 6 and 9

Wire up the grid circuits of the two last tubes, including the grid terminals of tube sockets G and H and the secondary terminals of the transformer J, and the binding post No. 7.

Next, connect the jack M to the output terminals of the transformer K and the condenser P. This is rather a difficult job, as there is not much room to work. Be sure that the wires do not short-circuit between the jack and the terminals of the transformer.

The last job in wiring is to connect up the plate circuits of the last two tubes. This work will include the plate terminals of the two tube sockets G and H, the primary terminals of the transformer K and the connection to the binding post No. 10.

When this is finished the wiring job is complete.

How to Set Up the Amplifier

Place the amplifier on the table, after the sides, back and lid have been screwed on, alongside of the single-tube set (or other type of set) and connect up the receiving unit as usual, with a six-volt "A" battery and a 22½-volt "B" battery.

To add the amplifier to any single-tube receiver, connect two wires from the posts Nos. 1 and 2 on the amplifier, in place of the telephones that are ordinarily used on the receiving set. This places the primary of the transformer I in series with the plate circuit of the detector.

There should be no other audio-frequency amplification used except what is contained in the amplifier itself.

Next, run two leads from the "A" battery used on the detector, to the posts Nos. 3 and 4 on the amplifier. Be sure that you get the correct polarity. (See Figure 1.)

Now obtain three 45-volt sections of "B" battery, and connect two of them in series, 90 volts, between the posts Nos. 5 and 6. The

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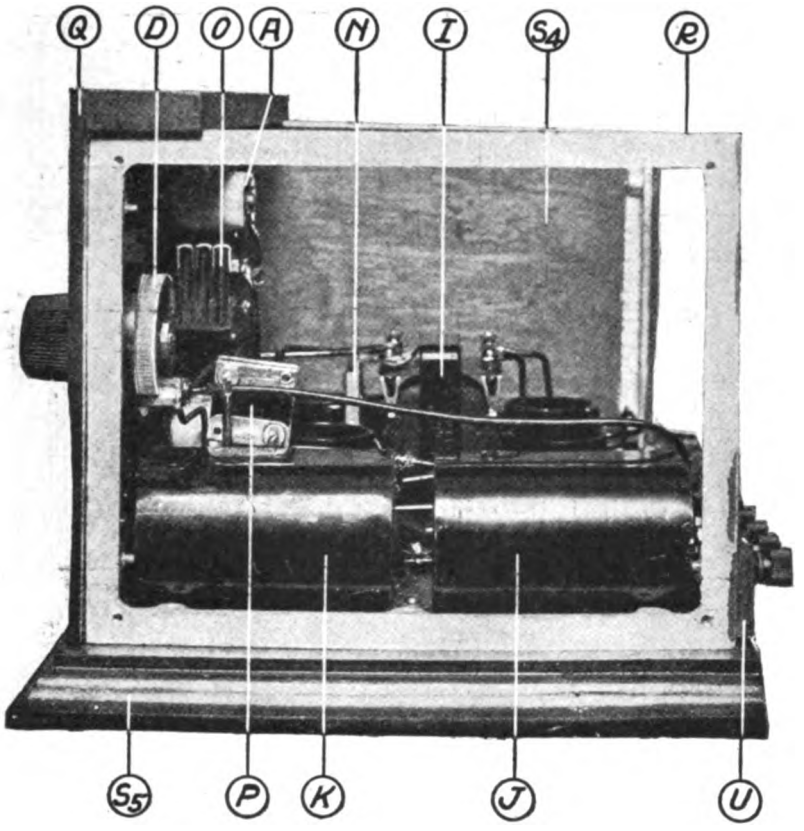

VIEW OF THE AMPLIFIER, AS SEEN FROM THE RIGHT

FIGURE 7: *Here we see the two push-and-pull transformers, one of the rheostats, the mica fixed condensers and the edge of the binding-post connection block which is screwed to the frames.*

positive terminal should be connected to post No. 6. (See Figure 1.)

Next, connect two Eveready "C" batteries, of 4½ volts each, in series, giving 9 volts, between the posts Nos. 7 and 8. Post No. 8 is positive.

The last connection will be the third section of "B" battery, 45 volts, between the posts Nos. 9 and 10, with the positive connected to post No. 10.

The amplifier is now ready for use.

Operating Data

Tune in a signal on the detector, and then turn up the knobs of the grid-leak B and the resistor A on the amplifier with a clockwise motion until they are practically all in. Then insert the loudspeaker plug into the jack M.

Turn up both rheostats about four-fifths of the way—and you should immediately hear the signals issuing from the loudspeaker.

Then adjust the rheostats to best signal strength.

Next, adjust the resistor A to best position for loudest signals; this is done by rotating counter-clockwise. If rotated too far, the signals will disappear.

Finally, adjust the grid-leak B for both loudness and clarity. The best way to get the most out of the amplifier would be to place a D.C. milliammeter with a scale reading from 0 to 20 milliamperes in series with the negative lead from the "B" battery; the lead running to post No. 5.

For best results the normal plate current will be found to be around 8 to 10 milliamperes. This condition may be arrived at, as stated before, by experimenting with the adjustment of the grid-leak, the resistor and the tube filament currents.

The tubes used by the author were C-301-a tubes and UV-201-a tubes. In turning up the filaments they should not be increased beyond the point where no additional signal strength is gained by doing so. If this precaution is observed it will add to the life of the filaments.

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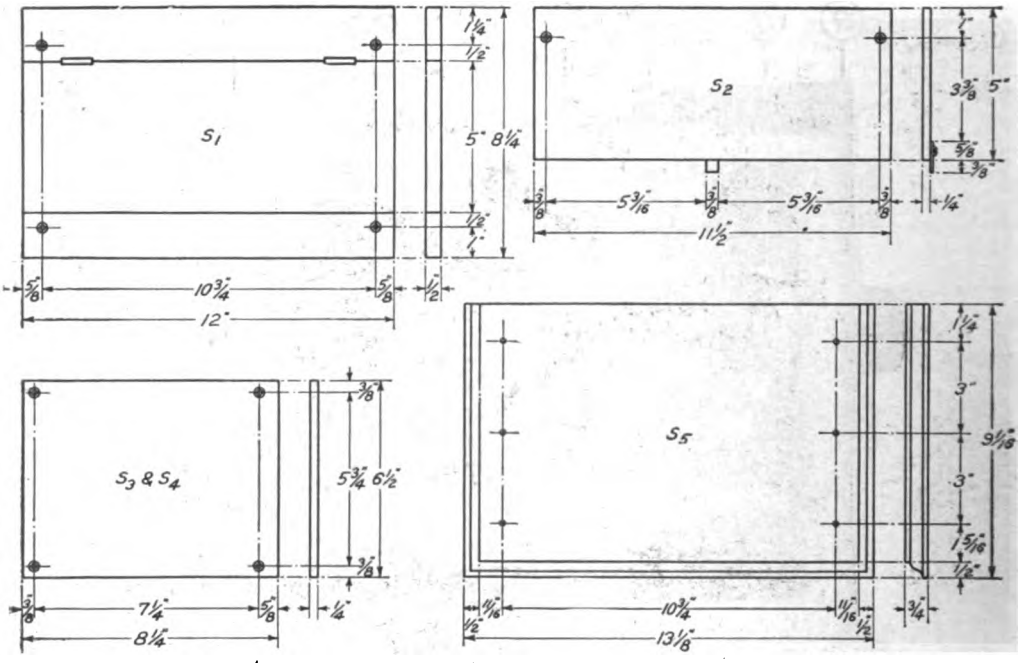
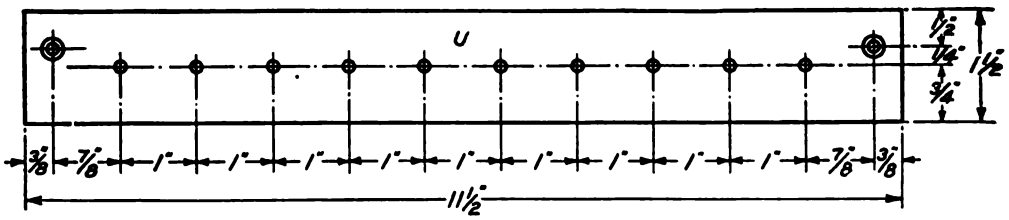


THE DIMENSIONS FOR THE WOODEN PANELS THAT FORM THE CABINET

FIGURE 8: *At the top (left) is shown the three pieces which form the hinged lid for the top of the cabinet. At the top (right) is the wooden panel for the back. At the bottom (left) is the drawing of the piece used for each side, and at the right is the base. This drawing may be turned over to a cabinet maker if desired.*



THE DIMENSIONS FOR THE CONNECTING BLOCK

FIGURE 9: *This block is made of panel material and is drilled (as shown above) for the ten binding posts and also for the two screws, one at each end, which are used to attach it to the amplifier frames.*

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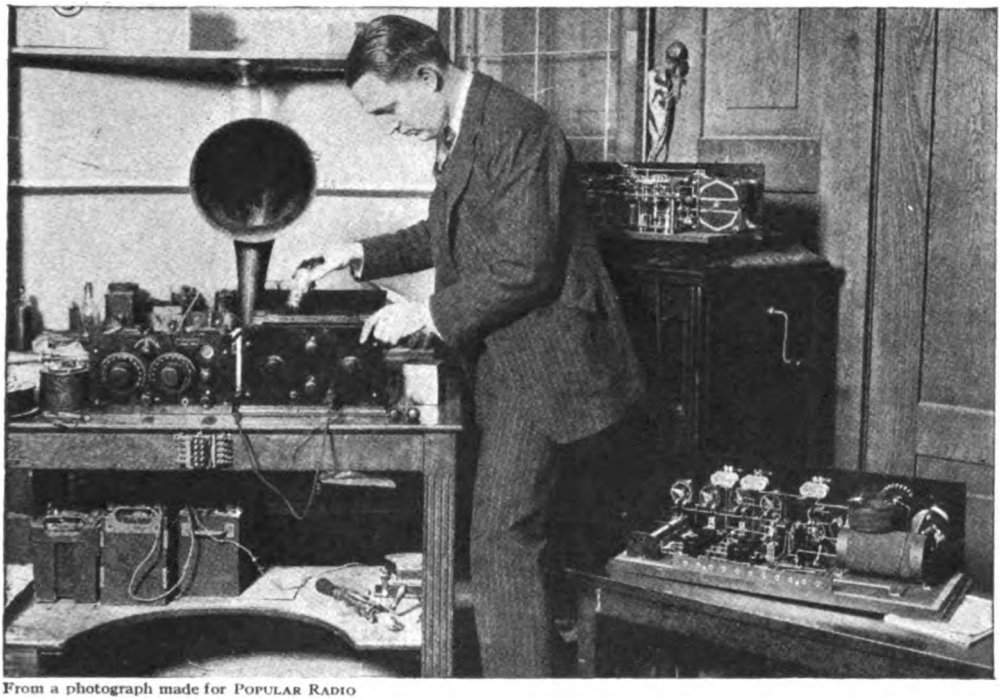

From a photograph made for POPULAR RADIO

INSTALLING THE AMPLIFIER IN ADDITION TO A SINGLE-TUBE, FOUR-CIRCUIT SET

FIGURE 10: *The amplifier uses four tubes of the thoriated filament type, and the total drain on the storage battery is only one ampere. The "C" batteries used on the last two tubes keep the plate current small and improve the quality of the received signals.*

Be sure that when the amplifier is connected to a single-tube regenerative receiver, the amount of regeneration is not increased to too great a point, for if this is done the signals will be subjected to distortion in the detector circuit, as mentioned previously in this article. All the amplifier could do in this case would be to amplify the distorted signals thus supplied to it and the result would be anything but pleasant to listen to.

It is a requisite, then, that a good detector and tuner be used with the amplifier in order to get the results that *can be obtained.*

Be sure, in getting a loudspeaker for use with this device, that one with a large volume capacity is obtained; otherwise it will vibrate or rattle.

How to Build a Receiver that Works on an Indoor Antenna

DON'T *worry even if your landlord won't let you put up an antenna! In the next issue of* POPULAR RADIO *will appear another of these constructional articles telling how to build a set that operates on an indoor aerial. This set has been carefully tested in the laboratory for several weeks and will prove a boon to those who are so situated that they cannot put up an outdoor antenna, and who cannot afford a multi-tube receiver.*

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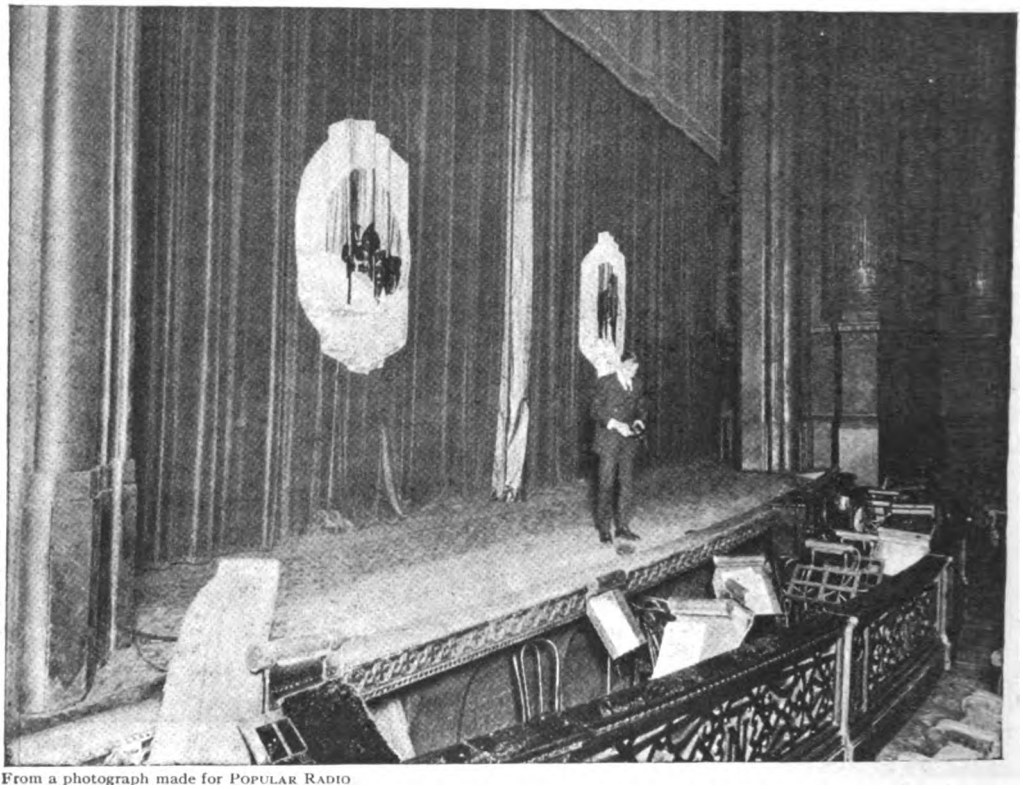

From a photograph made for POPULAR RADIO

HOW PLAYS ARE BROADCAST DIRECT FROM THE STAGE

Microphones are installed among the footlights and the performance is transmitted by wire to the broadcasting station. The above picture was made at the Century Theatre in New York.

Will Radio Create a New Form of Dramatic Writing?

"The broadcasting of dramatic compositions that are written to be acted cannot be given a proper performance by a reading alone," is the opinion of the present-day dramatists, whose spokesman is himself a famous dramatist—

EDWARD CHILDS CARPENTER

READERS of the newspapers were recently surprised to read in glaring headlines the statement:

DRAMATISTS OPPOSE RADIO

The "story" that followed explained that the Board of Directors of the American Dramatists and the directors of the Playwrights' Association (whose membership embraces nearly all the active and successful dramatists in the country), had recently met and had taken definite action to prevent the broadcasting of their plays—without

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the author's consent. Following the meeting this statement was made to the press:

"The majority of the playwrights are opposed to the broadcasting under any circumstances, and propose to deny the release of their plays for that purpose, contending that in the radio they are hurting the value of their play for use on the stage. We are notifying all the radio stations and all the dramatic agents of our decision, at the same time sending them a copy of our resolution.

"The resolution passed by the playwrights reads as follows:

"At a meeting of the Board of Directors of the American Dramatists held on February 5th, 1924, it was RESOLVED: That henceforth the American Dramatists would not permit the broadcasting of the plays of any member without the written consent of the member to the broadcasting station;

"That this resolution is arrived at inasmuch as the plays of members are fully protected against unauthorized broadcasting, both under the copyright law and at common law, and inasmuch as it is a fundamental principle of literary property that dramatic, literary and artistic works may not be reproduced in any way without the consent of the author, either with or without payment of royalty;

"That it is essential to the best interests of the members of the American Dramatists that their plays be not broadcast without their written consent, since in the estimation of the American Dramatists broadcasting is injurious to the production value of a play and tends to lessen the desires of the public to attend the regular performances."

Unusual interest has been aroused by this action of the playwrights because it raises, not only the question of what plays may be broadcast, but also how they may be broadcast. And it opens up the pertinent question as to whether or not radio may not develop an entirely new form of dramatic writing to fit its special needs. This possibility was more than hinted at by Mr. Edward Childs Carpenter, the president of the American Dramatists, when he told POPULAR RADIO that broadcasting a play would considerably lessen, if not wholly destroy, its artistic worth.

"Radio is, after all, but the *hearing* of the words of the play," stated Mr. Carpenter. "A play is written to be *performed*. Without actors any play is bound to lose its effectiveness. The appeal of any play is plus the action on the stage, and no play really has been properly presented, nor has the integrity of the author's idea been preserved without the complete presentation *in a theatre*, with production, costumes, scenery, music, lights and the other elements that go to cast the atmospheric spell intended by the playwright. Without all these

From a photograph made for POPULAR RADIO

"PLAYWRIGHTS ARE OPPOSED TO BROADCASTING PLAYS UNDER ANY CIRCUMSTANCES"

So states Mr. Edward Childs Carpenter, representing the American Dramatists. "Radio is but the hearing of the words of a play; a play is written to be performed." Will plays be written to be heard only?

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International

"BEHIND THE SCENES" AT A BROADCASTING STATION

The broadcasting of plays and other theatrical entertainment is usually done from the studio—as shown above. This picture shows station WHN, atop the State Theatre in New York, while Will Morrissey, the comedian, is broadcasting a part of his act.

appurtenances no play can be said to be complete. Hence the mere hearing of the words of a play is a great injustice to both the author and his handiwork."

This point has already been anticipated by the radio experts as well as by some of the enterprising playwrights themselves, and several plays have already been broadcast that were written and presented with this specific form of presentation in view. It is not at all improbable that radio will evolve a technique all of its own in the matter of dramatic productions.

But there is another phase of the subject that is of no less interest to the professional dramatist; will the broadcasting of his play increase or decrease its commercial value to him? And this is the problem that directly touches the dramatist's pocket. On this point also Mr. Carpenter speaks for the dramatists.

"It is quite obvious," he states, "that a play, once broadcast word for word and scene for scene, would be so familiar to playgoers throughout the country as to quite destroy its value as an entertainment should a manager later decide to send it out on the road or to grant its release for presentation by stock companies. Obviously the surprise element in plays forms one of the attractions to playgoers. Very few persons would care to go to see a play whose every word and scene they had heard over the radio."

Here Mr. Carpenter hits upon a vital point. The dramatist, properly enough, wants broadcasting to increase the value of his play to him. Among the plays along Broadway today there are several whose value might possibly be jeopardized by the mere reading of their lines. As an example, there is the play of the

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Dramatists' Theatre, Inc., "The Goose Hangs High," the worth of which lies to a great extent in the atmosphere created. It is doubtful whether the hearing of the lines of this play would give any conception of the play's atmosphere of a middle western home. A direct-from-the-stage broadcast might be unintelligible to the radio audience. There are at least a dozen plays in New York whose worth would be similarly underestimated by a radio presentation. Perhaps for this very reason the dramatist feels that he should be compensated for a broadcast presentation.

"The majority of our members," continued Mr. Carpenter, "are opposed to the broadcasting of their plays under any circumstances, but in cases where they may wish to release their plays, a fee will be charged on the same basis as that which obtains when a play is released for stage presentation, either as a road attraction or for presentation by a stock company. The amount of this fee would be a matter to be settled between the radio broadcasting station and the author or his representative, and the amount involved naturally would revert to the playwright as in all other cases where a play is released on a royalty basis."

"What," inquired POPULAR RADIO, "is the attitude of your organization toward the broadcasting of plays direct from the theatre during an actual performance; that is, broadcasting by what is technically known as the 'pick-up' system?"

"I can see no difference whatever between this method and the reading of the text from a radio station," replied Mr. Carpenter, "except to say that it would be more life-like, more nearly like actually sitting and enjoying the performance. Therefore, since this method would rob the performance of all elements of newness when it is viewed later in the theatre by those who 'saw' it by radio, it is even a more harmful manner of broadcasting than the usual one, and we are utterly opposed to it."

But Mr. Carpenter sees no harm in a review of a play being sent forth by radio, any more than he sees harm in the reviews of dramatic critics as published in the newspapers and magazines. But even in this case, he does not believe the complete story of a play should be given, for the reason that two of the greatest elements in the theatre are atmosphere and illusion and once a play is robbed of these, its value as entertainment and its artistic worth are greatly impaired.

Photonews

Miss Almeda Fowler—who is reported to be "the only woman radio operator afloat"—taking a lesson from Chief Wireless Officer C. S. Rosenthal of the GEORGE WASHINGTON.

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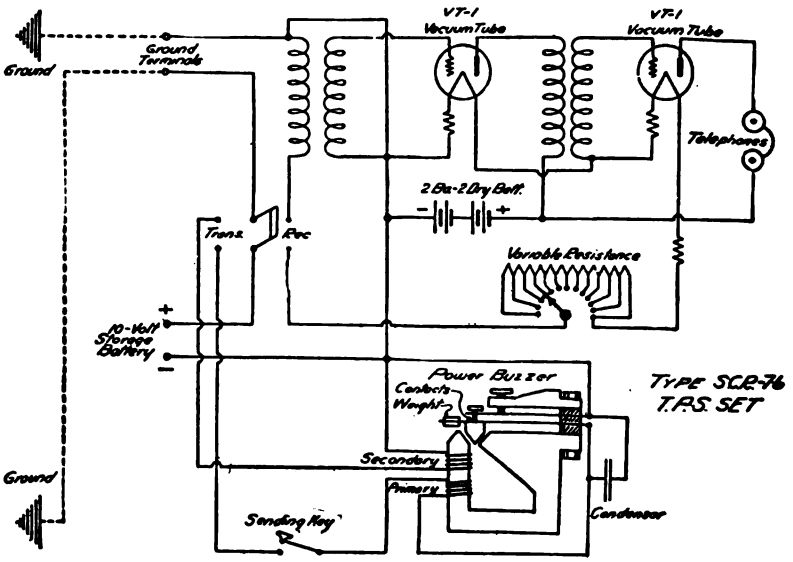

FIGURE 1: *This diagram shows the electrical circuits for the common transmitter and receiver used in this audio-frequency system of underground telegraphy.*

Underground Radio Telegraph

—THAT EXPERIMENTERS CAN REALLY USE

Four or five radio enthusiasts who live in the same neighborhood can easily install the unique underground telegraph system that is described in this article. Interference will not bother them—nor will they create interference for others.

By S. R. WINTERS

A DUPLEX radio-telegraph set, designed for communication over considerable distances and which is immune to both static and interference, has been developed by the Signal Corps of the United States Army according to what is called the T.P.S. or soil-telegraph system. In this apparatus the earth is used as a medium for the transmission of the radio waves.

This outfit, capable of both transmitting and receiving messages, consists of an adjustable-frequency power-buzzer, a Morse telegraph key and a two-stage audio-frequency vacuum-tube amplifier. A 10-volt storage battery is employed to operate the power-buzzer and to light the filaments of the vacuum tubes.

The ordinary radio-telegraph receiving apparatus, when similarly connected to the ground, serves to intercept the communications thus conducted through Mother Earth. The pulsating currents impressed on the soil at the transmitting station are broken up into the dots and dashes of the code by means of an ordinary telegraph key. Identical ground connections and the same 10-volt

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storage battery are employed for both sending and receiving messages through the earth. This twofold purpose is accomplished by the use of a switch mounted on the panel.

The power-buzzer is of a double-coil type with a closed magnetic circuit. A condenser is connected across the vibrator contact points to minimize sparking and to improve the tone of the buzzer. The screw on top of the buzzer is adjusted until a healthy, clear note is obtained; it is then locked by a set screw. The two-stage audio-frequency amplifier employs two vacuum tubes and two iron-core amplifying transformers; it is provided with jacks and binding posts to connect with the telephone receivers in the plate-circuit of the tubes. The filaments of the latter are placed in series with the 10-volt storage battery. The three fixed resistances have an aggregate value of 3.9 ohms; a 6 ohm variable resistance in series with the filament circuit is used for adjustment.

A selector switch permits communication between a central station and any outlying stations, as illustrated in Figure 2.

In the Signal Corps' portable outfits twelve ground rods are supplied with each radio-telegraph set, six being used at each end of the wire marking the base line of the stations. At least four rods should penetrate the earth in a straight line at each end of the base, the distance apart being not less than two feet.

When a communication is to be transmitted the selector switch is rotated to the position indicated for transmission, the telegraph key is put into operating position, and the buzzer adjusted to a distinct note of the desired frequency. Dots and dashes impressed on the earth in this method spread themselves in all

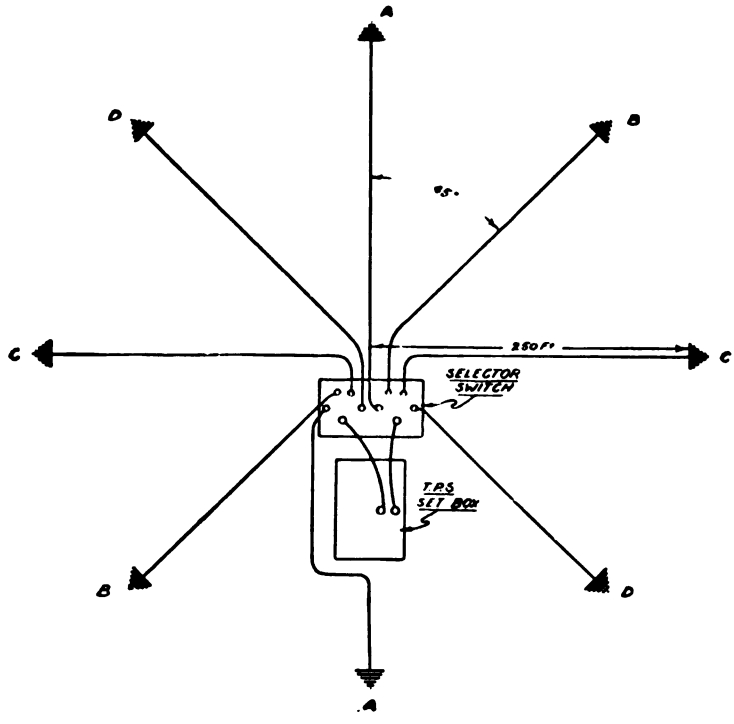

FIGURE 2: *How the grounds and the selector switch are arranged to permit communication from a central station in various directions. The combination of grounds used determines the direction of transmission and reception.*

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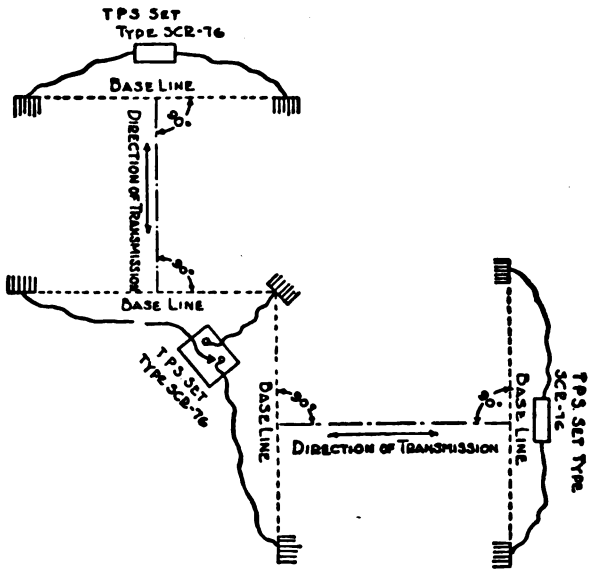

FIGURE 3: *This diagram illustrates the arrangements for communication between the central station, in the lower left-hand corner of the diagram, and two outlying stations, one above and one to the right.*

directions for interception by sensitive receiving devices. These receiving devices are similarly grounded.

Urge the Passage of the White Radio Bill!

THE *bill introduced by Congressman W. H. White, known as the "Radio Bill," is now pending in the House of Representatives. Its most important features provide for widening the regulatory powers of the Department of Commerce over broadcasting and over other forms of land radio. Many disquieting features of the present radio situation—for example, the prevalence of regenerative interference or the threat of a monopoly in broadcasting—will be much less dangerous if the Department of Commerce is given more definite powers. For this reason, particularly, Mr. White's bill deserves the support of the radio public.*

Write your Congressman today and tell him so!

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CONDUCTED BY DAVID LAY

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to have.*

School Education by Radio

THE first public school system to make radio an official part of its efforts toward general education is that of New York City. The Board of Education, which controls all of the city's schools, has appointed an official radio committee, a transmitting microphone has been installed in the offices of the Superintendent of Schools and a regular program of educational material will be broadcast from WJZ.

* * *

How to Locate Troublesome Re-radiation

THE engineers of the London broadcasting station keep a map of the city, into which they stick pins of different colors to indicate the locations of trouble reports from listeners. A black pin indicates reported interference by code, a green pin marks a report of annoyance by amateur transmission and a white pin shows a claim of trouble due to re-radiation from the oscillating receiver of another listener. When the white pins begin to be thick in some one part of the map the engineers go out on a hunt for the offending listener.

* * *

Delicate Thermometer is Disturbed by Radio Effects

IN recent experiments at the Mount Wilson Observatory, reported in *Popular Astronomy*, Dr. Abbott of the Smithsonian Institution made use of a photoelectric device for measuring the temperature of distant stars, one part of this device being an electric thermometer so delicate that it could record a temperature change of 1/100,000,000 of a degree. So sensitive was this apparatus to minute electrical impulses that disturbances originating from electric machinery in Pasadena, nine miles away, became a serious trouble. It is believed that these disturbances were conducted up the mountain along the power wires, just as the radio impulses of carrier-current telegraphy are conducted.

To Study Air Conditions by Experimental Explosions

THE fact that the transmission of sound through the air has some analogies to the transmission of radio waves has been noted several times in POPULAR RADIO. The sound waves going outward from great explosions display, for example, phenomena of "fading" of "dead spots" and others resembling in many ways the phenomena of radio. These sound effects are now to be studied more exactly by scientists attached to the French Government. In May of this year ten-ton quantities of high explosives are to be set off. The exact minute of the explosion will be announced in advance and a large number of observers will be prepared to record the loudness and the exact instants of arrival of the sound wave in all directions around the place of explosion.

* * *

Mountain Static Makes More Trouble

THE U. S. Forest Service has had to close its radio station on Medicine Bow Peak, Wyoming. It had been planned to use this station for broadcasting reports of forest fires but the static proved so troublesome that the station was of little value. Someone ought to find out why it is that static and mountains go together so often.

* * *

The Oldest Kind of "Wireless" Goes Over the Radio

STATION WHAZ broadcast recently the sounds of the drums, tom-toms and other instruments used by the Iroquois Indians in their methods of sending signals over long distances long before the discovery of America by Columbus. WHAZ is in Troy, New York, formerly the heart of the country ruled by the Iroquois Nation. Doubtless many Indian messages were broadcast over this same territory centuries ago but none went so far or so fast as this latest one.

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Radio on the Round-the-world Air Flight

THE call letters WYZ have been assigned to the radio installation for the round-the-world airplane expedition to be attempted this summer by U. S. Army fliers. Radio will be used only on the last leg of the flight, from England to the United States. The necessary weight of the radio equipment persuaded the officers in charge not to attempt to use it on the trip across the Pacific or along the southern coast of Asia.

* * *

Germans Claim Interference with Their National Anthem

GERMAN newspapers are protesting that whenever "Deutschland über Alles" is broadcast from Berlin the ether becomes filled immediately with tremendous interference on the same wavelength "coming from the general direction of the Eiffel Tower." Who can it be?

* * *

British Broadcasting Received in India

"THE thrill that comes once in a lifetime" must have visited the listener in Calcutta, India, who recently received by accident a part of a program broadcast in England. Radio telegraphy between England and India has been in regular operation for some time but this is the first instance of telephony between the two countries.

* * *

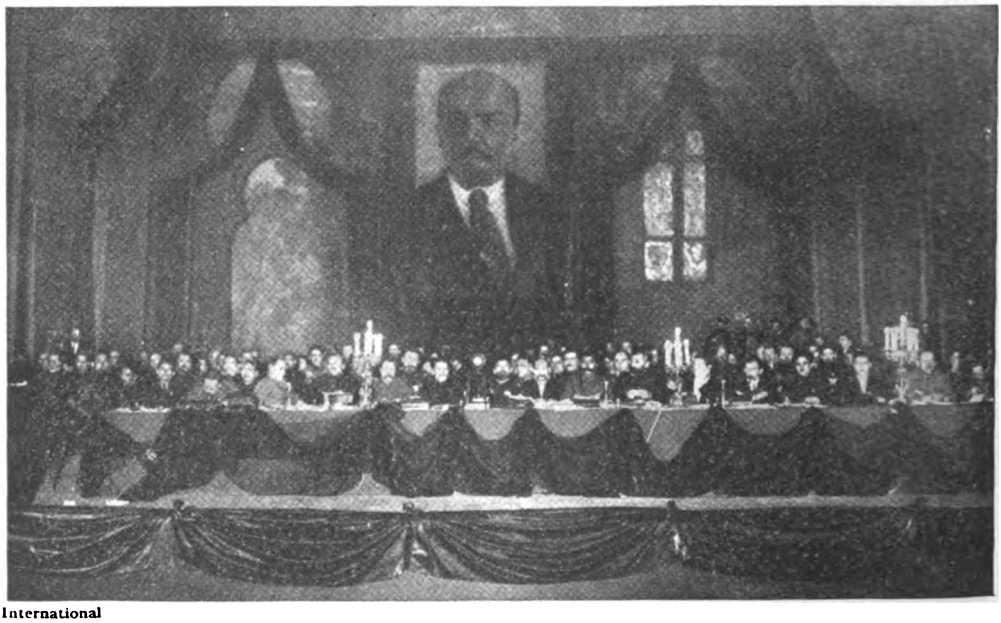
Fading Tests to be Made in France

TESTS of the fading of radio signals, along the same lines tried in the United States by the American Radio Relay League and the U. S. Bureau of Standards, are to be carried out this year in France. French amateurs are asked to make careful records of signal strength from moment to moment for both the French stations and the British broadcasting stations. The tests are being organized by the *Comité Français de Radio-télégraphie Scientifique.*

* * *

A Telephone Lineman Saves an Historic Broadcast Service

ON the afternoon when the memorial services for President Wilson were to be broadcast from WCAP, WEAF and WJAR, it is reported that Mr. C. H. Williams, a telephone lineman of Providence, Rhode Island, noticed that a tree, damaged by the storm, was about to fall across the telephone line over which the services were to be relayed between Washington and Providence. Quickly throwing a loop of rope over the threatening tree, Mr. Williams wrapped the rope around another tree and hung on. There he stayed for two hours, until the services were safely over. Then he let go. The tree promptly fell and took the wire with it.



International

BROADCASTING THE LAST SESSION OF THE SOVIET CONGRESS

On the table directly under the draped picture of Lenine may be seen the microphone by means of which the proceedings of this meeting in the Congress Chamber of Moscow were transmitted—in much the same way as other political proceedings are now being broadcast.

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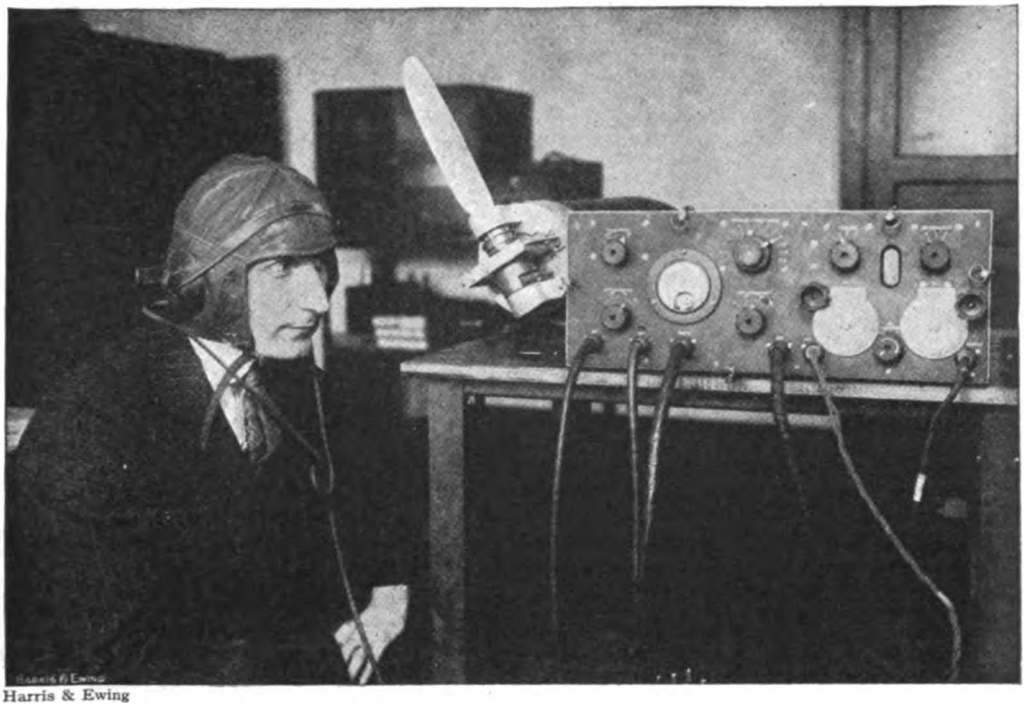

Harris & Ewing

THE NAVY'S NEW VOICE FROM THE AIR

This new transmitter and receiver for airplane use has been designed by the Bellevue Research Laboratory of the United States Navy. The wind-driven dynamo at the left supplies the current. The set itself is completely air-tight and water-tight.

Attending Technical Conventions by Radio

ONE of the things that every engineer tries to do, if he possibly can, is to attend the annual conventions of the national engineering societies to which he belongs. But it is not always possible to go. Can one stay at home and attend too? It seems possible that this may happen through radio. The American Institute of Electrical Engineers has opened the way for broadcasting a part of its recent meeting at Philadelphia. Before long we may see the entire convention of this and other technical societies sent out, by relay, from a half dozen stations, so that engineers who cannot leave their business will be able, nevertheless, to listen to the papers and addresses that they most desire to hear.

* * *

Sunday Radio Listening Illegal in New Jersey

AN ancient law, passed in 1798, has been revived in New Jersey by advocates of "Blue" Sundays. Although the resurrection of this antique statute was intended primarily to close up the Sunday movies, it appears that the law makes illegal the operation of a phonograph or even of a radio receiver on the Sabbath. The penalty for violation is a fine of one dollar.

New Instrument Uses Principle of Carbon Grid-leak

THE Bureau of Standards has perfected a new instrument for indicating pushes and pulls in the beams of a structure of any kind, for example, in the metal trusses of a rigid airship like the *Shenandoah*. A little tube filled with carbon disks is inserted in the truss. The pressure or tension on this device changes the electric resistance of the pile of disks and this difference in resistance can be read off on a meter located anywhere; for example, in the control cabin of the airship.

* * *

The First Endowment of Broadcasting

A STEP which may have far reaching importance on the future of radio was taken recently in New York when an organization called the "Radio Music Fund Committee" was formed by Mr. Clarence H. Mackay, Mr. Felix M. Warburg, Mr. Frederick A. Juillard and Mr. A. D. Wilt, Jr. All these gentlemen are wealthy patrons of music and of the other arts. They propose to provide, themselves and by public subscription, a fund which will be available to pay artists and to defray the other expenses of broadcasting music of the highest type from New York.

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Radio in Architectural Plans

RADIO equipment is becoming so necessary a part of the modern dwelling house that many architects in the eastern cities are now providing for the antenna, ground, wire conduits and the like when the house is built. In numerous cases receivers, loudspeakers and audio-frequency distributing systems have been actually built into the walls.

* * *

The Largest Dance in the World

ONE of the New York orchestras that sends out dance orders to its listeners recently received requests from more than 1,250 separate dance parties on a single night. At an average of ten persons at each party, which is probably below the truth, this would mean that over 12,000 persons were dancing to this orchestra's measure. And this leaves out of account the probable thousands of anonymous dancers who did not apply for orders at all.

* * *

Static in the Mexican Mountains

IT is announced that communication between the new government station at the Panama Canal, operating as NBA, and stations on the California coast of the United States is almost impossible because of a "dead spot" that intervenes. A glance at the map shows that this dead spot occupies, in all probability, the location of those northern mountains of Mexico whose role in the creation of static has been under discussion recently in POPULAR RADIO. There must be *something* unusual about those hills; maybe the ghosts of the Spanish conquistadors who died there are still in possession.

* * *

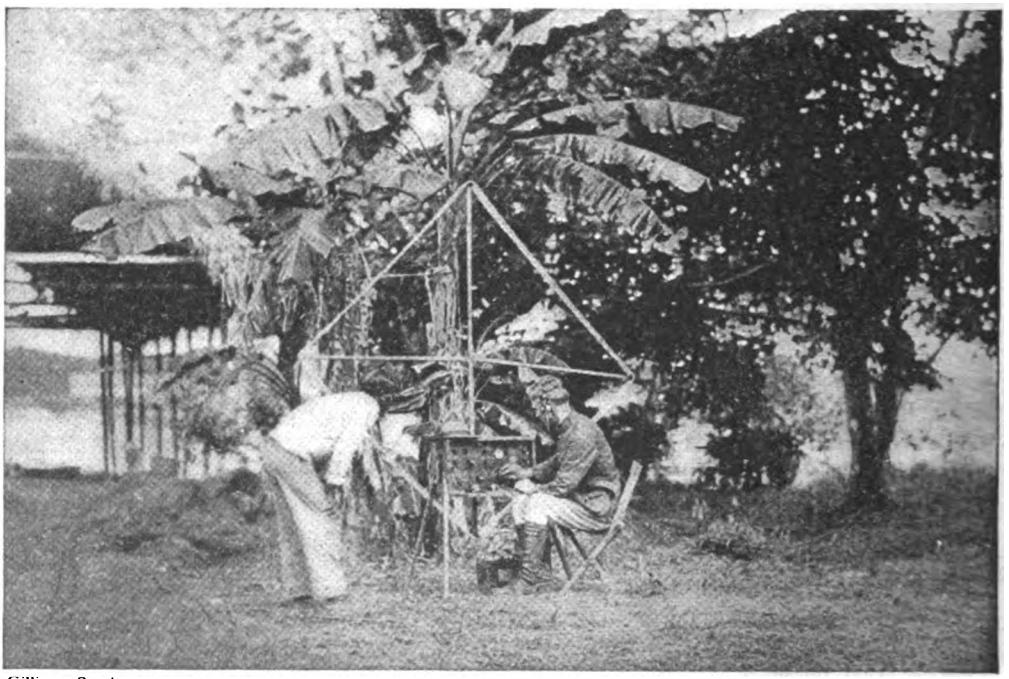
New Chemical Element May Find Its First Use in Radio

A FEW months ago a new chemical element, *Hafnium*, was discovered by Doctors Coster and Hevesey at the University of Copenhagen. Now it is suggested (in *Beama*, London) that this latest addition to the chemical family has properties that are likely to make it valuable for some of the parts of vacuum tubes.

* * *

Radio Restores the Lost English H's

A STORY from London is to the effect that listening to radio broadcasting has distinctly improved the spoken English of the youngsters in the city's East End. The "uncles" who do the announcing and tell the stories have the most impeccable Oxford accents. The result is that the listeners imitate them and the missing "h," so long a characteristic of the Cockney speech, seems to be coming back.



Gilliams Service

RADIO AMONG THE HEAD-HUNTERS

On his expedition among the savages of the Amazon country in South America, Dr. Alexander Rice kept in constant touch with civilization by means of his radio set. A new expedition now planned to the same region will have still more complete radio equipment.

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Louis Zoul

A BLIND BUILDER OF RADIO SETS

This picture shows Joseph Alonzo of New York, who for the past ten months has been sightless but who, despite this handicap, has built some of the receivers described in POPULAR RADIO. *He uses sticks of various lengths for his measurements.*

Should Personal Licenses be Required for Radio Operators?

ONE of the subjects now under active discussion at Washington is whether the present requirement of personal licenses for operators of commercial and amateur stations shall be dropped or shall be continued. Advocates of dropping this feature of the present law urge that a license for the *station* is sufficient, the owner being held responsible for its proper operation by a competent person, just as the railways are now held responsible for the competence of their locomotive engineers. The point will doubtless come up for discussion in Congress in connection with the new radio bill proposed by Congressman W. H. White. Radio fans who have strong opinions on the matter may write their Congressmen about it.

* * *

Radio Reaches the Sleeping Brain

THE discovery that code can be learned by listening while asleep was described by Mr. Kenneth Swezey in POPULAR RADIO for December, 1923. An additional fact comes from the Great Lakes Training Station of the U. S. Navy. A radio instructor was sending code to a number of sleeping sailors as a part of the use of the new sleep-listening method. As he finished he sent, also in code, this sentence: "Get up, it's five-fifty-five." To his astonishment, all the pupils promptly awoke. It is evident that the sense of the message, as well as its code signals, reached the unconscious minds of the sleeping men.

* * *

A Remarkable Radio Relay Experiment

THE most ambitious experiment in radio relaying ever attempted was carried out successfully on the evening of February 8, 1924, when a speech by General John J. Carty of the American Telegraph and Telephone Company was broadcast simultaneously from seven stations, including two in California and one in Cuba. The speech was delivered in the Congress Hotel in Chicago. Land telephone lines aggregating more than 5,000 miles carried the general's words to the six American stations and the Cuban telephone cable took them to Havana. It is estimated that more than 100,000,000 people could have heard this speech with receiving sets costing less than twenty dollars each.

* * *

Still Another Name for Radio Listeners

CLOSE on the heels of "cohearers" the British fans have another suggestion of something to call the radio public. The new one is "comradios" and it is due to the staff of the Cardiff station of the British Broadcasting Company.

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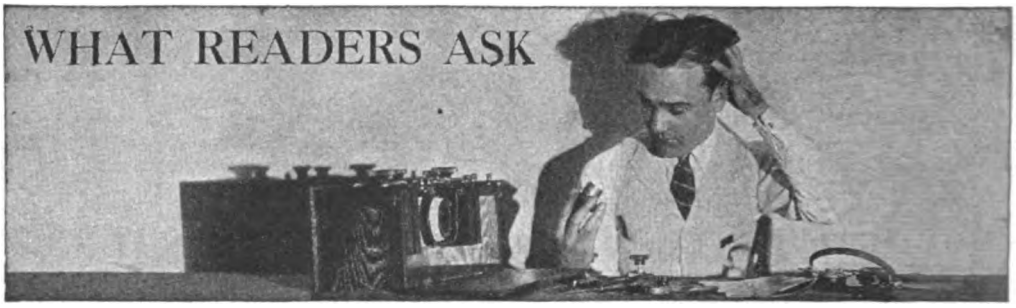

CONDUCTED BY LAURENCE M. COCKADAY

A Simplified Reflex Circuit

QUESTION: Please give me a simple reflex circuit for using one tube and a crystal with tuned-radio-frequency amplification. JOSEPH P. BYRON

ANSWER: The circuit is drawn in Figure 1. The circuit shown includes a single stage of tuned-radio-frequency amplification with a crystal detector and a single stage of audio-frequency amplification. The plate circuit is directly coupled to the detector circuit by means of a tuned impedance. All the tuning is accomplished by means of two variable condensers.

You will need the following instruments and parts:

L1 and L2—honeycomb or duolateral coils, size L-75
VC1—variable condenser, .001 mfd.
VC2—variable condenser, .0005 mfd.
C1—mica fixed condenser, .0005 mfd.
C2—mica fixed condenser, .0005 mfd.
C3—mica fixed condenser, .00025 mfd.
R—filament rheostat, 20 ohms
AFT—audio-frequency amplifying transformer
DET—crystal detector
TEL—telephones
An amplifier tube should be used.

Choose a Loud Speaker Suitable to Your Set

QUESTION: What is the best loudspeaker to use for volume and clarity and which is usable on any set?

ARTHUR GRANT

ANSWER: We advise you to go to a reliable retail store and have them demonstrate the various types of loudspeaker, so that you can purchase the one that suits you best. If possible, have them make these demonstrations on a set like the one you are using. In this way you will be sure of satisfaction.

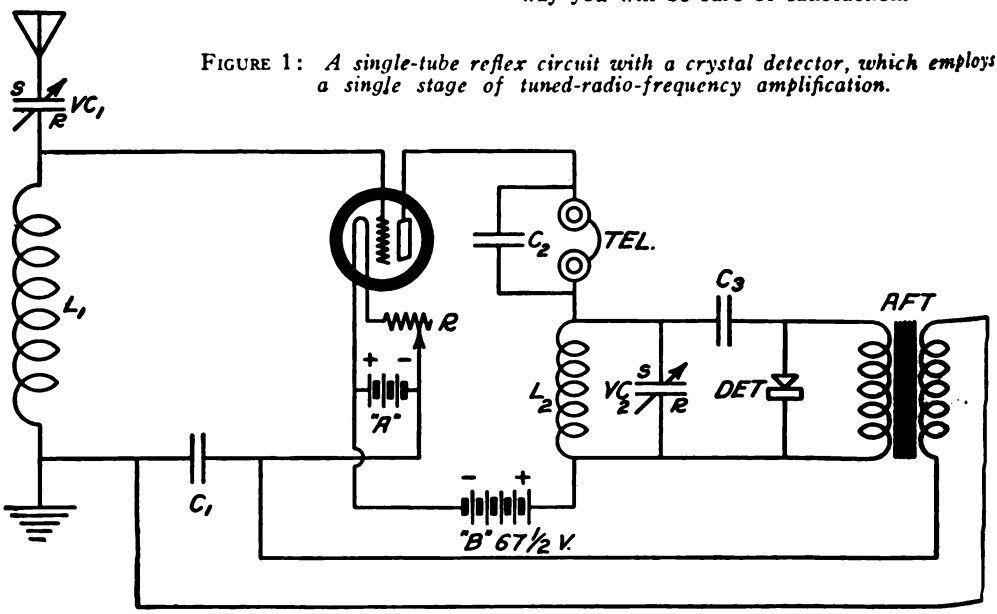

FIGURE 1: *A single-tube reflex circuit with a crystal detector, which employs a single stage of tuned-radio-frequency amplification.*

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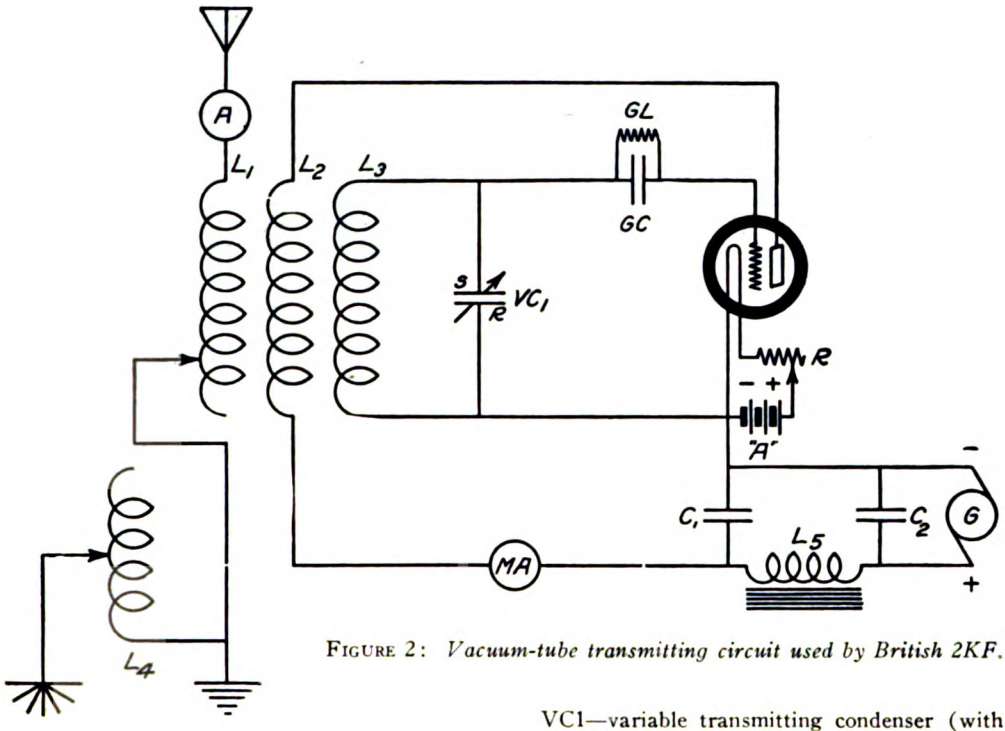

FIGURE 2: *Vacuum-tube transmitting circuit used by British 2KF.*

An Efficient CW Telegraph Transmitter

QUESTION: Will you please give me the circuit used by British 2KF in his station that has been heard in America. All I need is the circuit itself as I can figure out the proper constants for the apparatus myself.

A. E. J.

ANSWER: The circuit used is shown in Figure 2. The coils can be made in the following manner: Coil L2 can be made of 50 turns of No. 14 bare stranded wire on a 6-inch tube, with the wires spaced far enough apart so that clips can be used for getting the correct inductance in the circuit. Coil L3 may be wound of 40 turns of the same wire on a 3-inch tube inserted inside the coil L2. Coil L1 can be wound directly over the coil L2 with heavily insulated wire, with taps spaced about every two turns. Coil L4 is simply a loading coil for the counterpoise circuit and should be variable to include the proper amount of inductance to tune it to the same frequency as the rest of the antenna circuit.

The other parts you will need are:

A—hot-wire ammeter, with proper scale reading for the tube used
MA—D.C. milliammeter, with proper scale reading
VC1—variable transmitting condenser (with wide spacing), .0005 mfd.
R—filament rheostat, to suit tube
C1—paper condenser, 2 mfd., capable of standing plate voltage
C2—paper condenser, 2 mfd., capable of standing plate voltage
L5—radio-frequency choke coil
G—motor generator
GL—grid-leak, to suit tube used
GC—mica fixed condenser, .0005 mfd.

Notice that both a regular ground and a tuned counterpoise are used.

Proper Resistance to Use in a Resistance-coupled, Audio-frequency Amplifier

QUESTION: Will you please give me the value of the coupling resistance that can be used for a resistance-coupling audio-frequency amplifier? Also what value of resistance should be used for the grid-leaks and what capacity for the grid condensers?

LAWRENCE J. FEENY

ANSWER: The coupling resistance should be approximately 100,000 ohms. The grid-leak should be variable, one that can be controlled down to a fairly low resistance. The grid condensers should be .005 mfd. (for the first stage) .015 mfd. (for the second stage) and 1 mfd. (for the third stage).

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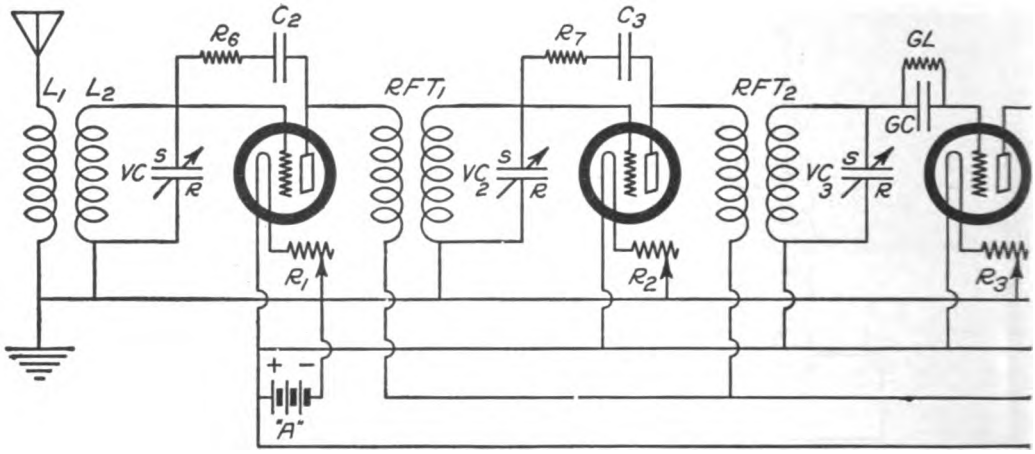

A New Method for Preventing Feed-back in a Radio-frequency Amplifier

QUESTION: Is there any other method for preventing oscillation in a radio-frequency set, other than the use of the potentiometer or the neutrodyne system? I am an experimenter and find a great deal of pleasure in trying out new ideas. I have a group of friends who are doing the same thing and we have quite a time in trying to outdo each other in a competitive way. Some of them are neutrodyne fiends, some of them are trying to get the super-heterodyne to work and some are boosters for the four-circuit.

So, if you can give me any dope on anything new I would be much obliged and possibly could beat them to it.

S. F.

ANSWER: We have drawn for you, in Figure 3, the circuit diagram of a receiver employing two stages of radio-frequency amplification, detector and two stages of audio-frequency amplification. The method for neutralizing feed-back in this receiver is known as the Farrand pliodyne system.

The feed-back is eliminated partly or wholly by employing a non-inductive high resistance in series with a small condenser connected across between the grid and the plate of the tubes.

The parts you will need are the following:

L1 and L2—ordinary variocoupler (primary and secondary windings)
VC1, VC2, and VC3—variable condensers, .00025 mfd.
C1—mica fixed condenser, .0005 mfd.
C2 and C3—small mica fixed condensers, about .0001 to .002 mfd.
GC—mica fixed condenser, .00025 mfd.
GL—variable grid-leak
R1, R2, R4 and R5—filament rheostats, 20 ohms
R3—filament rheostat, 6 ohms
R6 and R7—Lavite resistances, 25,000 ohms
J1 and J2—double-circuit jacks
J3—single-circuit jack
RFT1 and RFT2—radio-frequency transformers
AFT1 and AFT2—audio-frequency transformers

A soft tube such as the C-300 or the UV-200 is used for the detector (third tube) and all the others may be either UV-201-a's or C-301-a's.

The radio-frequency transformers may be made by winding 25 turns of No. 24 DSC wire on the center of a composition tube, 3½ inches long and 1¾ inches in diameter, for the primary coil. The secondary coil consists of 100 turns of the same sized wire wound centrally on a composition tube, 3½ inches long and 2 inches in diameter. The primary is then slipped inside the secondary coil and fastened. This insures close coupling between the two circuits.

The primary windings should be wound in one direction and the secondary windings should be wound in the other direction.

You will have to experiment somewhat in finding the correct capacity to use for the small condensers C2 and C3.

You may also add as many stages of radio-frequency amplification as you want to obtain the sensitivity necessary for your needs.

Tuning Out Inductive Interference

QUESTION: I live near the New York, New Haven and Hartford Railway and have just put up a fine receiving set. At times I can get nearly all the long-distance broadcasting stations in the eastern

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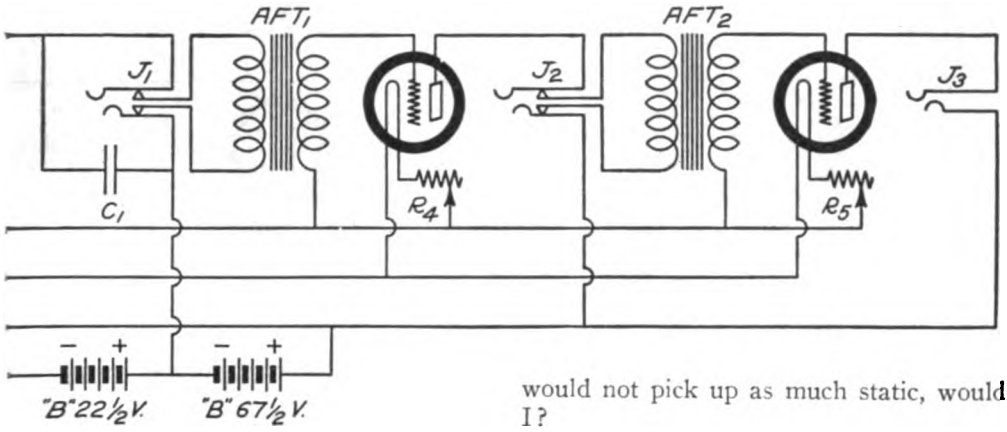
FIGURE 3: *The Farrand pliodyne receiver, with a new method for eliminating feed-back.*



half of the country, but at other times I am bothered by a continuous crackling sound, something like static, which completely drowns out reception even from the local stations. Is there any remedy for this?

A neighboring amateur tells me that he has the same trouble and that it comes from electric leakage from the high-tension power lines of the railroad. Would a loop receiver help in eliminating this trouble?

JOHN H. WILLIAMS

ANSWER: This is probably what causes the trouble you experience. The loop receiver would help to tune out the interference only if the interference comes from some particular direction. This would be done by turning the loop until minimum interference was picked up from this direction. However, *all* signals from this direction would, at the same time, be eliminated. There has been no sataisfactory solution for this interference up to the present time.

The Super-heterodyne on a Loop Antenna

QUESTION: Can the super-heterodyne receiver, described in the September, November and December issues of POPULAR RADIO, be modified to work on a loop antenna? If so, I would like to know where I can obtain information about it. I have the set now and would like to use it this summer, but I fear that it would be very susceptible to static. With the loop, I would not pick up as much static, would I?

LAWRENCE MEEHAN

ANSWER: The super-heterodyne you mention will operate well on a loop antenna and this use of it will eliminate a lot of static interference in summer work.

An article describing the necessary modifications of the set will be found in the near future in an issue of this magazine.

The Best Detector to Use in the Super-heterodyne

QUESTION: Will a soft detector tube give better results in the super-heterodyne receiver described in the November and December issus of POPULAR RADIO? The article specifies a UV-201-a tube.

FRANK KELSEY

ANSWER: We recommend the use of the tube specified. This will give the same signal strength and reception will not be accompanied by the familiar hiss of the gassy tube.

The Whistle in a Single-tube, Super-regenerative Receiver

QUESTION: Can the whistle be eliminated from a single-tube super-regenerative receiver?

HOWARD BRENT

ANSWER: As far as we know, it cannot. It is not possible to put a filter in the detector circuit which will filter out the high-frequency whistle which accompanies reception with this type of receiver, without also filtering out some of the important frequencies which are necessary to reproduce good music and speech. It might be done if a crystal detector is used with a single tube in this circuit.

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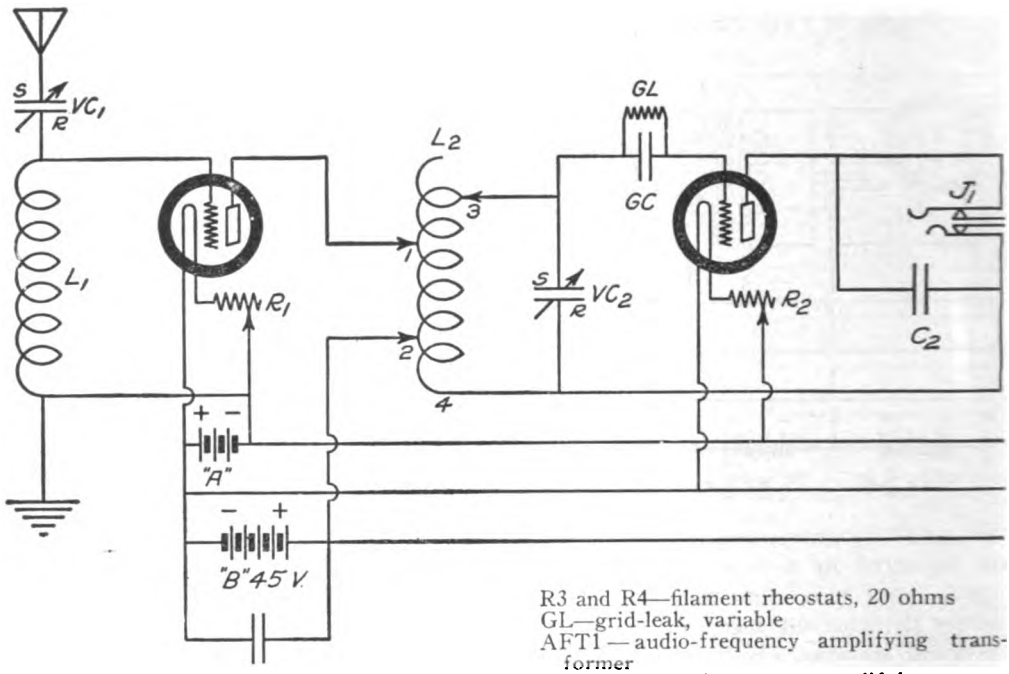

French Tuned-radio-frequency Receiver

QUESTION: Can you give me any particulars regarding the French circuit known as the Abelé circuit? I have a cousin who just arrived back from Paris and he tells me it is great, but he could not get the data on how to build it. Can you get it for me?

ANDREW H. BLONT

ANSWER: The circuit you want is shown in Figure 4. We have shown a single stage of radio-frequency amplification, detector and two stages of audio-frequency amplification, so that it may be used on a loudspeaker. It is interesting to note that in this circuit, the plates of the two first tubes are coupled together with the grid circuit of the second tube through a radio-frequency auto-transformer. The three couplings can be varied by means of the sliders or taps on the coil L2.

The parts you will require are the following:

VC1—variable condenser, .001 mfd.
VC2—variable condenser, .0005 mfd.
C1—paper fixed condenser, .5 mfd.
C2—mica fixed condenser, .0005 mfd.
GC—mica fixed condenser, .00025 mfd.
L1—60 turns of No. 20 DCC wire on a composition tube, 3½ inches in diameter
L2—60 turns of No. 24 DCC wire on a composition tube, 3½ inches in diameter. This coil should be tapped every 2 turns
R1—filament rheostat, 20 ohms
R2—filament rheostat, 6 ohms
R3 and R4—filament rheostats, 20 ohms
GL—grid-leak, variable
AFT1—audio-frequency amplifying transformer
AFT2—audio-frequency amplifying transformer

The tubes used can be three UV-201-a's or C-301-a's for the radio and audio-frequency amplification, and a C-300 or a UV-200 tube for the detector.

You will have to gain a little experience in obtaining the correct ratios for the inductance taps included in the output of the first tube and included in both the input and output circuit of the second tube to get the best results from the circuit. • When you have learned this it should be found an extremely sensitive circuit, although rather critical.

Small or Large "B" Batteries

QUESTION: I have a five-tube receiver. I need 135 volts of "B" battery to operate it. Should I use small or large sized "B" batteries with it, or doesn't it matter? The large "B" batteries take up so much room that I would like to use the small ones if the efficiency of the set were not affected.

A. D. CROWLY

ANSWER: We recommend the use of the large size of "B" batteries wherever possible. Especially where there are more than three tubes used. The larger batteries have a much longer life than the other ones and there is less possibility of them running down and spoiling reception.

The small "B" batteries should be used only where portability is absolutely necessary.

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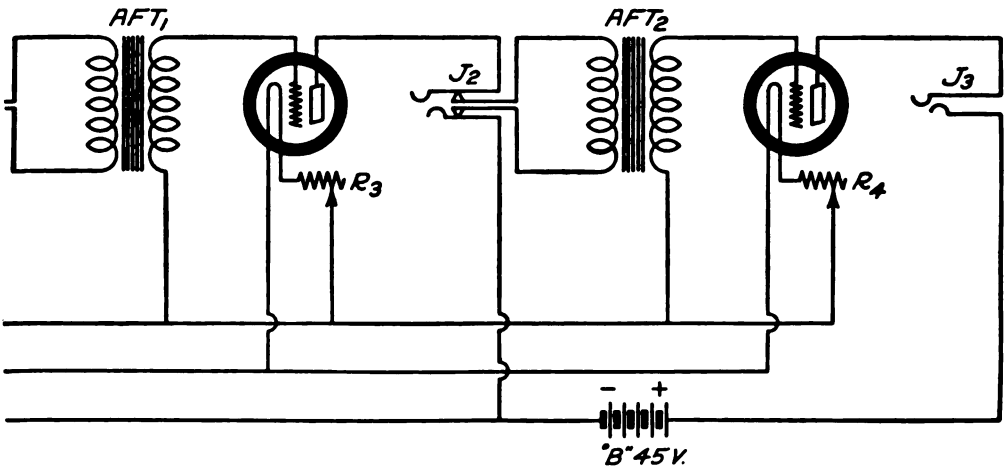
FIGURE 4: *The Abelé circuit comprising one stage of tuned-radio-frequency amplification, detector, and two stages of audio-frequency amplification.*



How to Make a Neutrodyne

QUESTION: You have never shown the amateurs how to make a neutrodyne type of receiver in your magazine. Is this because you do not think it is an efficient circuit or is it too complicated for the ordinary radio fan to build with any success?

S. F. G.

ANSWER: It is rather difficult to completely neutralize the tube capacity in the regular neutrodyne on account of the extremely small value of capacity that is usually used for this purpose.

However, in Mr. Craig's article, "How to Build a Simplified Neutrodyne," in the April, 1924, issue, you will find that he has made this phase of the adjustment much easier by neutralizing with a larger capacity in a capacity bridge. This greatly simplifies the problem.

Grounding the Cores of Amplifying Transformers

QUESTION: I have a two-stage, audio-frequency amplifier that I made to use with my single-tube receiver, and which gives me good loudspeaker volume. The only trouble I find is that there is a constant high-pitched whistle which is on all the time I am receiving. I can eliminate this by turning down the last tube filament considerably, but then the signals sound strained and are reduced in volume.

While experimenting with the set, I touched the core of the last transformer with my bare hand and the whistle vanished without affecting the volume of the set with the tubes turned up to the point where maximum amplification is obtained. Immediately I thought of grounding the metal parts of the transformer. I did this and the effect was the same. The whistle was eliminated.

I want to know if this harms the amplifier in any way? Does it damage the transformer? Will it run down the "B" batteries? If not, this would be a valuable thing for other experimenters to know, I think.

HOWARD BROECK

ANSWER: The method you used is standard practice and will not do any damage to the instruments. It is usually best to ground the negative terminal of the "A" battery and then attach a wire from there to the transformer core (underneath the screw which is used to fasten the transformer to the base).

This will do what you want and will help in eliminating body capacity in some of the circuits where the secondary coil of the tuner is connected direct to the grid and plate elements of the detector tube, instead of to the grid and filament elements.

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CONDUCTED BY RICHARD LORD

A limited number of questions of general scientific interest will be answered each month in this department. Readers are invited to send in questions that have puzzled them—but the selection of questions for answer cannot be guaranteed nor can questions outside the radio field be answered by mail.

How much amplification is possible in the best receivers yet devised?

IN theory there is no limit to the amplification that can be attained. Practically, however, very high amplifications are difficult to reach without introducing too much distortion. Many of the modern circuits will reach successfully an amplification of from 30,000 to 100,000 times the strength of the incoming signal. Amplifications of several million have been obtained experimentally and some sets, handled by an expert, will do this in practice.

What is "spaghetti" made of?

IT is thin cloth, usually a kind of muslin, wrapped or woven into the form of a tube and saturated with insulating varnish.

Can condensers be connected in series and in parallel the same as resistances or batteries can?

THEY can be so connected but the capacity of the combined units will not be the exact sum or difference of the individual condensers. Capacities cannot be added or divided by the simple rules that apply to battery voltages.

Why is it that the carbon in carbon rheostats changes its electrical resistance with the amount of pressure you put on it?

THIS is not quite the right way to state what happens. The carbon is not all in one solid piece but is in powder or in flat disks or in some other kind of separate particles. The electrical contacts between these particles are not perfect. The more pressure you apply the better the contact between the particles. They are merely pressed together more completely. This decreases the electrical resistance, not of the carbon itself, but of the mass of particles.

Has a perfect vacuum ever been obtained in vacuum tubes?

No. Science has never obtained a perfect vacuum in any way whatsoever. A really perfect vacuum is probably unobtainable under the conditions that exist on earth. See "The Bottle Filled with .000,000" in POPULAR RADIO for October, 1922.

Why are the iron magnets inside transformers, motors and other electric machines always made out of thin sheets of iron instead of solid castings?

To prevent what are called "eddy currents." If the iron is in a solid piece the electromagnetic waves that pass through it produce a lot of electric currents that merely flow around as eddies inside the iron itself and this wastes energy.

Why does dropping a telephone receiver sometimes ruin it, although nothing is broken?

THE shock when it hits the floor weakens the magnetism in its magnets. According to present day theories of magnetism, the magnetic force is due to the fact that every little atom of iron in a magnet is itself a tiny magnet. All these atoms are believed to be turned in the same direction so that their magnetic effects

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reinforce one another. The shock of dropping the magnet turns some of the magnetic atoms in other directions so that they interfere with the magnetic force of the unturned atoms. This weakens the whole magnet.

How can I make tellurium for a crystal?

You cannot make tellurium. It is a chemical element, like copper or silver or carbon. Crystallized tellurium can be bought from most dealers in chemical supplies or in rare minerals. It is extracted commercially as a by-product of copper refining.

What are the "talking crystals" that I read about? Will they repeat radio signals without telephones?

You are confusing two entirely different things. The so-called talking crystals are not detector crystals for radio. They are crystals of rochelle salt that can act, under proper circumstances, like a microphone or a telephone. That is, they can convert sound waves into electric waves or *vice versa*. They have no present use in radio. There was an article about them in POPULAR RADIO for September, 1922.

Is there any kind of amplifier for radio-frequency currents instead of the vacuum tube?

THEORETICALLY there are a number of such amplifiers, for example, the magnetic amplifiers which make use of a magnet vibrating in a combined electric and magnetic field. But all these devices are very poor substitutes for a vacuum tube. They have a considerable inertia of the vibrating parts, which means that they affect the wave forms of the currents or potentials amplified and produce distortion. The vacuum tube is the only amplifier that has proved generally useful in practice.

How can I build a transformer for use on direct current?

THIS cannot be done. The principle of the transformer applies only to *alternating* current. Each time the direction of the current changes a magnetic wave is produced around the primary coil and this wave creates the pulse of current in the secondary coil. If the current does not change there is no such alternating magnetic wave and accordingly no current is produced in the secondary.

How many electrons are there in the atoms of all the metals?

THE number varies for the different metals. The following table gives the number of planetary electrons in one atom of each of the chemical elements, including the metals. These numbers are for the electrons that revolve around the nucleus, or atomic sun, as the planets revolve around the sun of our solar system. There are additional electrons inside the nucleus, but these do not affect the ordinary chemical or electrical properties of the elements. This is explained in the article, "Bohr's New Theory of Atoms," in the April, 1924, issue of POPULAR RADIO.

Elements	*Number of Planetary Electrons*	*Elements*	*Number of Planetary Electrons*
Hydrogen	1	Silver	47
Helium	2	Cadmium	48
Lithium	3	Indium	49
Beryllium	4	Tin	50
Boron	5	Antimony	51
Carbon	6	Tellurium	52
Nitrogen	7	Iodine	53
Oxygen	8	Xenon	54
Fluorine	9	Caesium	55
Neon	10	Barium	56
Sodium	11	Lanthanum	57
Magnesium	12	Cerium	58
Aluminum	13	Praseodymium	59
Silicon	14	Neodymium	60
Phosphorus	15	*Undiscovered element.*	61
Sulphur	16	Samarium	62
Chlorine	17	Europium	63
Argon	18	Gadolinium	64
Potassium	19	Terbium	65
Calcium	20	Dysprosium	66
Scandium	21	Holmium	67
Titanium	22	Erbium	68
Vanadium	23	Thulium	69
Chromium	24	Ytterbium	70
Manganese	25	Lutecium	71
Iron	26	Hafnium	72
Cobalt	27	Tantalum	73
Nickel	28	Tungsten	74
Copper	29	*Undiscovered element.*	75
Zinc	30	Osmium	76
Gallium	31	Iridium	77
Germanium	32	Platinum	78
Arsenic	33	Gold	79
Selenium	34	Mercury	80
Bromine	35	Thallium	81
Krypton	36	Lead	82
Rubidium	37	Bismuth	83
Strontium	38	Polonium	84
Yttrium	39	*Undiscovered element.*	85
Zirconium	40	Niton	86
Columbium	41	*Undiscovered element.*	87
Molybdenum	42	Radium	88
Undiscovered element.	43	Actinium	89
Ruthenium	44	Thorium	90
Rhodium	45	*Undiscovered element.*	91
Palladium	46	Uranium	92

The elements beyond Bismuth are radioactive.

Working Blueprints of the Audio-frequency Amplifier

IN order to accommodate readers who may desire actual-size diagrams of this, the amplifier described on pages 476 to 485, a set of three blueprints has been prepared, consisting of—

One panel pattern (actual size);

One instrument layout;

One picture diagram of all parts, showing the wiring.

This set of three prints will be forwarded, postage prepaid, upon receipt of $1.10.

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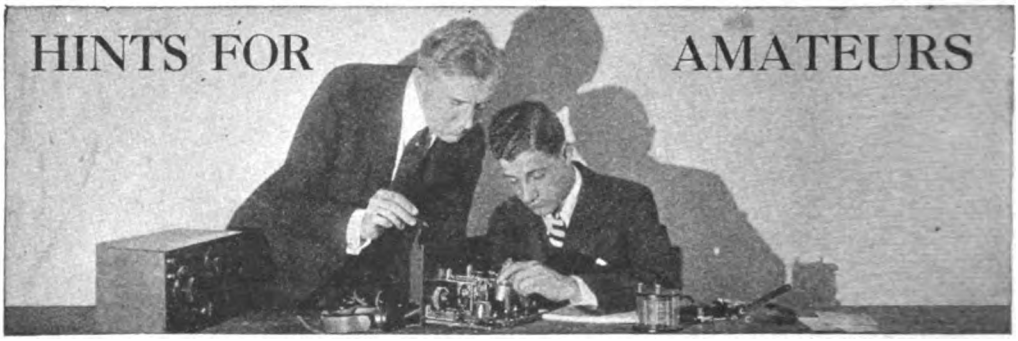

CONDUCTED BY ALBERT G. CRAIG

Another Warning Against Re-radiation

DON'T let your set oscillate while you are receiving on the broadcasting wavelengths. It will not be of any advantage to you and will prevent your neighbors from getting clear reception on account of your set re-radiating. *Don't do it!*

The Best Wire for Your Antenna

SEVEN-STRAND pure copper wire is the best material to use for an outdoor antenna. The size most generally used is No. 14 B. and S. gauge wire.

Of course, No. 14 bare copper wire may be used, but the stranded wire will give a greater surface, which makes it more efficient at radio frequencies.

Too Much Regeneration

IF a regenerative receiver has a tendency to oscillate too much, even when the feed-back control is set as low as possible, the following suggestions may help to stabilize operation:

A—cut down the plate voltage on the detector tube
B—reduce the filament current
C—use a larger by-pass condenser across the telephones
D—connect the grid return to the positive side of the "A" battery
E—if three honeycomb coils are used for tuning use the next size smaller coil for the tickler
F—use a lower resistance grid-leak (a variable grid-leak would be best)
G—use a smaller grid condenser

BY following out one or more of these suggestions the trouble can be eliminated and the set will function much more smoothly. Try out all the schemes on DX reception and you may be able to increase the range of the set as much as one hundred percent.

Soldering Flux on Windings

BE sure (while soldering) that you do not allow the soldering flux to bubble and drop off a joint onto the windings of your tuning coils, as this destroys the insulation between turns and has been a frequent cause of inefficient operation of an otherwise really excellent set.

A Plate Milliammeter for a Receiver

To the experimenter who enjoys playing with new circuits when they come out, a D. C. milliammeter with a scale reading up to about 25 milliamperes will be a good indicator that the set is functioning properly. This is especially true for new amplifier hooks-ups. A meter which is reasonably "dead-beat" should be used.

Water Pipe the Best Ground

A WATER PIPE, if properly cleaned and a good joint made to it, will furnish a better ground, in most cases, than the radiator, the gas pipe, or a rod driven into the earth.

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Your Window-pane as a Lead-in

A GOOD lead-in can be made by coating a piece of tinfoil with shellac, and pasting it to the outside of the window-pane, and then doing the same thing on the inside of the window. The two sheets of tinfoil should occupy the same relative positions on both sides of the pane of glass. The antenna is connected to the outer sheet and the antenna binding post of the set is connected to the inside sheet. The two pieces of tinfoil act as a series condenser in the antenna circuit but the capacity is so high that the impedance offered to the radio-frequency signals is negligible.

Materials for Panels

Do not use fibre for panels in a radio instrument. It absorbs a large amount of moisture. You may, however, use this same material after it has been thoroughly dried in an oven and impregnated with a synthetic resinous compound. In this condition it is protected (to a fair extent) from moisture.

A Tip for Restoring the Efficiency of Coils

A HONEYCOMB coil that seems to have lost its efficiency through the warm, damp weather may be restored to usefulness by taking off the soft black strip of material (by loosening the two screws) and then baking the coil in a warm oven. Then, replace the black strip with a strip of isinglass or celluloid cut to the same shape. The black strip often collects a large amount of moisture, sometimes so much that you can squeeze it out of the strip.

Keep an Eye on Your Storage Battery

USE a hydrometer for testing out your storage battery. You can get one at almost any radio supply store. The directions furnished with the hydrometer will tell you how to test the battery to determine when it needs recharging.

A Tube Precaution

WHEN testing out a set that is just completed, do not put in all the tubes at once. Try out each socket one at a time and save a few tubes if you have made a mistake in connecting up.

Tag Your Battery Leads

A GOOD stunt is to have the leads from the "A" batteries and the "B" batteries tagged with little tags marked with the voltage and polarity for each lead. This will prove a reminder and prevent mistakes in selecting the proper lead wire to use.

Broadly-tuned Antenna Circuits for Receivers

A SEMI-APERIODIC (broadly tuned) antenna circuit will eliminate one tuning control in a receiving set, and will give quicker tuning control with very slight reduction in signal strength, if a regenerative circuit is used.

An aperiodic circuit is a circuit which has no natural period of oscillation; an untuned or non-resonant circuit.

A semi-aperiodic circuit is one (as already stated) that is only roughly or broadly tuned. It consists of a few turns (not more than 10) included in the antenna circuit, and coupled inductively to the secondary circuit which should be *sharply* tuned.

This is true of the Reinartz, Haynes, and some of the Cockaday circuits.

A Good Space Saver

THE use of a combination rheostat and socket is a good space saver in a receiver where compactness is one of your particular requirements.

Soft Tubes Best for Detectors

A SOFT tube, one that contains a lower degree of vacuum than a hard tube, is more sensitive as a detector, in a radio set. The hard tubes function best as amplifiers, however, while the soft tubes are not as suitable for this use.

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CONDUCTED BY DR. E. E. FREE

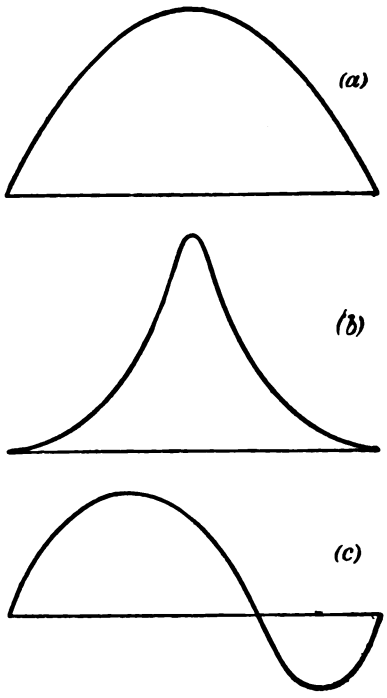
What Makes the Clicks and the Hisses in Static

THE pictures of different kinds of static obtained in England by Mr. Watson-Watt and his associates and described in an earlier number of POPULAR RADIO,* have recently been subjected to mathematical analysis by Mr. E. B. Moullin.† A formula has been found which fits fairly well the curves actually measured and this formula has been used to approximate the effects of tuned and untuned antennas and of other modifications of the receiving circuit upon the troublesomeness of the static disturbances.

Mr. Moullin's results apply in the main to radio telegraphy but one feature of his conclusions has interest for the broadcast listener as well. He finds that the actual effect of static is much more troublesome than the simple mathematical theory indicates that it ought to be. This is not because the theory is wrong. It is, he believes, because the most troublesome feature of static is not the main wave of it, but is the presence of shorter waves superposed on this main wave, shorter waves that may be called ripples on top of the main disturbance.

In a telephone receiver these short-wavelength ripples will make the hisses; the main long waves make the clicks. If Mr. Moullin's results prove to have general applicability it is the hisses rather than the clicks that trouble most greatly the clear reception of radio signals. How this conclusion can be applied practically to radio telephone receivers is not yet apparent, but the first step in controlling any natural phenomenon is to find out exactly what it is and this step we are taking rapidly.

* POPULAR RADIO, vol. 5, pages 205-206 (February, 1924).



COMMON KINDS OF STATIC

These curves represent the three commonest kinds of static observed by Mr. Watson-Watt and studied mathematically by Mr. Moullin, as described on this page.

Using Static to Forecast the Weather

IF the origin of static disturbances is to be ascribed to storms, electrical or otherwise, as seems to be the probable conclusion from the well-known work of Mr. Watson-Watt and others, then it should be possible to make use of these static waves to locate approaching storms and to forecast their probable movement and intensity. That this is being actually

† "Atmospherics and Their Effect on Wireless Receivers," paper before the Institution of Electrical Engineers (London), February 14, 1924, to be published in the *Proceedings* of the Institution.

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done in Europe at the present time appears from a brief review of the subject published recently by Mr. G. H. Daly.*

Experiments in both England and France have been promising. In particular, Professor Rothé of Nancy, France, has developed considerable skill in predicting the local weather from a study of the direction and character of static impulses received at his laboratory.

It would seem, however, that the mere direction of a static click is only part of the information that it can be made to yield about the weather. Nor is it the most important part, for the *location* of a distant storm can be learned without difficulty by telegraph from observers at that place, which is the present method of the United States Weather Bureau. A more valuable service of static to forecasting would be the determination, from the *character* of the static, of conditions in the higher levels of the atmosphere where there are no observers.

It is apparent to everyone who listens to radio that there are many different varieties of static. Some of the impulses are clicks, some are deep-toned rumbles, some are high-frequency hisses. Some of the more usual forms are indicated by the diagram published in this Department this month in connection with the article of Mr. Moullin. It is probable that each of these varieties has a different origin and it is almost certain that the whole orchestral score that static plays for us in our receivers has a meaning, a meaning which will help us solve many of the problems of the atmosphere and the weather.

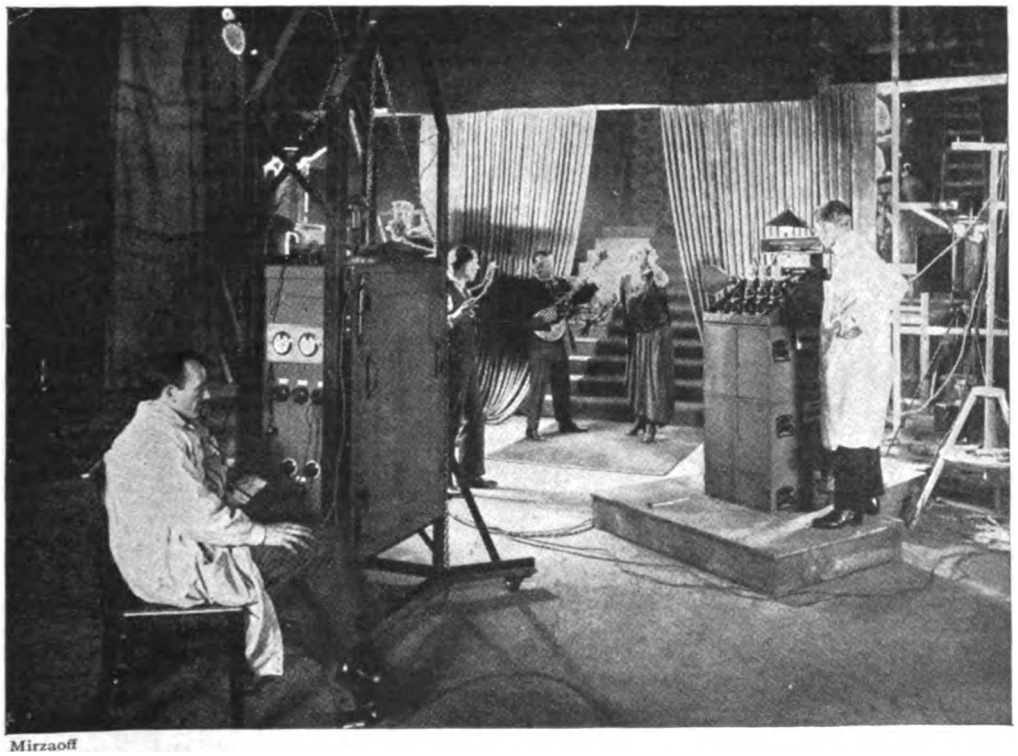
First, we must learn to read the meaning of this score and that will require, one imagines, a great deal of scientific observation and experimentation. But in the meantime, let us not regard static merely as an annoying nuisance. What it really is, is an incentive to scientific study, a signal that beckons to us from beyond the horizon of our present knowledge.

* "Forecasting Weather by Wireless," by G. H. Daly. *The Wireless Review* (London), vol. 2, pages 217-218 (January 26, 1924).

Progress with the Speaking Movies

THE phonofilm of Dr. Lee De Forest, a device already described in detail in POPULAR RADIO,* continues to approach perfection. It has been exhibited recently in a number of motion picture theatres with pronounced suc-

* "The Motion Picture Speaks," by Lee De Forest. POPULAR RADIO, vol. 3, pages 159-169 (March, 1923).



Mirzaoff

A STUDIO FOR THE NEW GERMAN "SPEAKIES"

While the motion picture camera records the action of the scene, the special sound-recording apparatus (shown at the right of the picture) makes a simultaneous record of the words and music. Note the three vacuum tubes that are used as amplifiers.

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cess and with much apparent interest on the part of audiences.

The reports of listeners agree, almost unanimously, upon two conclusions. *First*, it is apparent that the problem of synchronization, long so difficult to surmount, has been solved. Dr. De Forest's device actually does produce the sound at the instant of the action on the screen. *Second*, the chief present imperfection of the apparatus is that the sound seems unnatural. It sounds, one listener reported, "like an old-fashioned phonograph."

Presumably this unnaturalness of quality can be corrected in the phonofilm, just as it has been corrected so successfully in the best of the modern phonographs. And possibly the detailed studies of speech and of other sounds by Dr. Fletcher and his assistants, as described elsewhere in this Department, will prove of much assistance here as well as in the problems of loudspeakers and telephones.

A Mystery of Short-wave Transmission

ONE of the most interesting experiments now being carried out in the whole radio field is the relay work from KDKA at Pittsburgh to KFKX at Hastings, Nebraska, and to 2AC at Manchester, England.

As all radio enthusiasts know, this relaying is done on wavelengths in the neighborhood of 100 meters and has proved to be entirely successful in practice; not only are the programs from KDKA received with reasonable regularity both at Hastings and at Manchester but on several occasions the linkage has been extended from Hastings to the Pacific Coast and WGY at Schenectady, New York, has also been linked to KDKA. There seems every promise that the linkage of stations in this manner, by short-wave radio, is destined to replace, more or less completely, the present custom of linking stations by land-wire telephones.

A recent description of the Hastings Station by Mr. D. G. Little and Mr. F. Falknor* contains, not only the technical details that will interest primarily the professional radio engineers, but also some matters of general interest to the radio public. One of these is the problem of local interference at Hastings.

Because of the shortness of the wave that was arriving from Pittsburgh, substantial interference was encountered from leaky power lines in and about Hastings and from the electric apparatus used by physicians and dentists in the city. To avoid this the engineers determined how far this interference spread outside the city. It was found to be about one-half mile. Accordingly, the receiver for the KDKA wave was located about a mile north of Hastings, which was well beyond the zone of strong local interference. In addition a loop, opposed to the main receiving antenna, is used to cancel out what local interference remained.

Another ingenious expedient developed at Hastings has interest for experimenters everywhere; the vacuum tubes used on the transmitter used to re-broadcast the KDKA program to the Pacific Coast are water-cooled. The plates of these tubes come in contact with the stream of cooling water, yet they must be maintained at a high potential above ground.

To avoid using a self-contained and insulated system for the cooling water, the engineers connected the ordinary city water supply to the cooling circuit but made this water connection through twenty-foot lengths of rubber tubing ¼ inch in diameter. The electrical resistance of this long, thin water column is so great that practically no current leaks off the plates into the ground.

In deciding on the exact wavelength to be used in the relay link between Pittsburgh and Hastings some interesting observations were made on the variations in signal strength at different wavelengths. "Above 3,333 kilocycles (90 meters) it was found," say Mr. Little and Mr. Falknor, "that the signal was maximum about 7 P.M., central standard time, and would fall to about 10 percent strength before 8 P.M. At 3,000 kilocycles (100 meters) the signal strength increased until about 11 P.M. and then remained approximately constant until about 4 A.M."

In general, the waves shorter than about 90 meters were stronger in the daytime and weaker at night. Waves longer than 90 meters (up to about 100 meters) showed an exactly reverse effect. They were stronger at night and weaker in the daytime. An intermediate wave, slightly longer than 90 meters, showed about the same strength at all times, though this strength was less than either the daytime maximum of the 80-meter wave or the night-time maximum of the 100-meter one. To take advantage of this curious constancy in the audibility of the wave of intermediate length, the relay wave from Pittsburgh to Hastings has been set at approximately 3,200 kilocycles (94 meters).

To the radio scientist the most interesting feature of these curious results is speculation about what causes them. Mr. Little and Mr. Falknor have no suggestions to offer, nor has the editor of this Department. The variation in transmission of the two waves between night and day must remain, for the present, one of the many mysteries of radio propagation which we know about but do not understand.

The Papa Machine

BEFORE the meeting of the New York Electrical Society on February 28, 1924, Dr. Harvey Fletcher of the Western Electric Company exhibited a remarkable electrical machine. This machine, when adequately coaxed by Dr. Fletcher and his assistant, said "papa" and "mama" quite distinctly.

It consisted of a system of oscillating vacuum tubes that produced the vowel sounds necessary to these two words, together with

* "Radio Station KFKX, the Repeating Broadcasting Station at Hastings, Nebraska," by D. G. Little and F. Falknor. Statement issued to the press by the Westinghouse Electric and Manufacturing Co., March, 1924.

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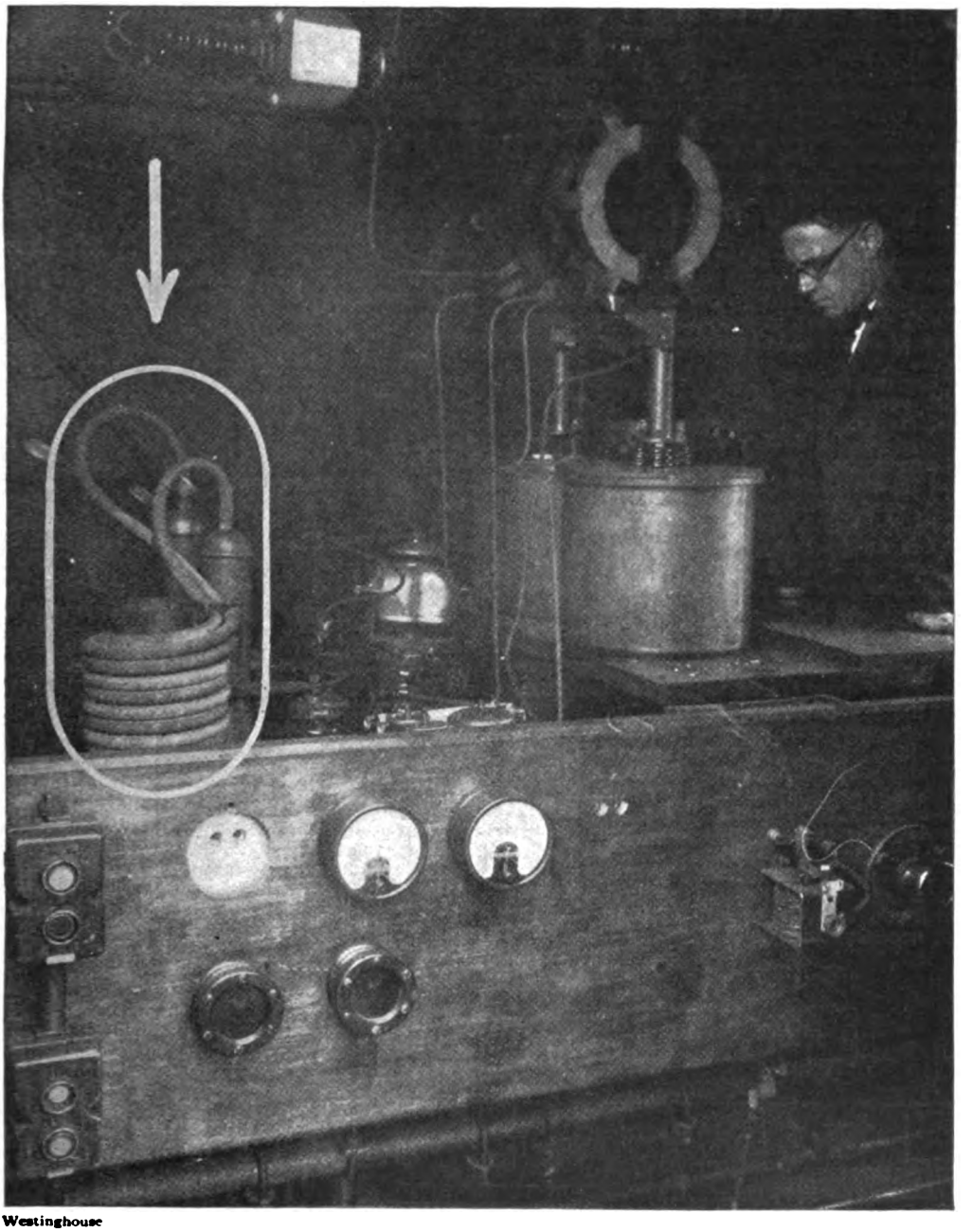

Westinghouse

THIS STATION RELAYS RADIO FROM PITTSBURGH TO CALIFORNIA

This shows part of the transmitter used at KFKX, Hastings, Nebraska, to retransmit the programs received from KDKA at Pittsburgh, Pennsylvania. Both legs of the trip are covered by short waves, in the neighborhood of 100 meters wavelength. Inside the white oval at the left is part of the rubber-tube water-resistance through which the city water supply is connected with the system that cools the plates of the transmitting tubes. The length of this water column prevents any important leakage of current to the ground.

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devices for stopping and starting the sound in a fashion competent to produce the consonantal sounds, "p" and "m."

Although this machine was the most spectacular incident in Dr. Fletcher's address, there was apparent, back of this achievement in artificial speech, a vast amount of research and ingenuity that has great permanent interest for the radio engineer. Dr. Fletcher and his associates have been able to analyze the physical nature both of human speech and of human hearing. They have studied, also, the physical nature of noise and they have combined this information, finally, into valuable deductions concerning the transmission of speech and other sounds electrically; both by wire, as in ordinary telephone practice, and by radio.

The outstanding fact about speech is that each vowel sound, like "a" or "ah" or "oo," consists of *two* fundamental frequencies or pitches. By sounding these two frequencies simultaneously Dr. Fletcher made his "papa" and "mama" machine pronounce these vowels with considerable similarity to the human voice. The consonants represent, also, certain pitches or frequencies, as well as the mere starting or stopping of sounds. Dr. Fletcher has constructed a set of electric filters or wave traps adapted to remove or to let through any desired group of frequencies of sound. Using these he demonstrated to the Society which frequencies are responsible for the vowel sounds of speech, and which (in the main) for the sounds of the consonants.

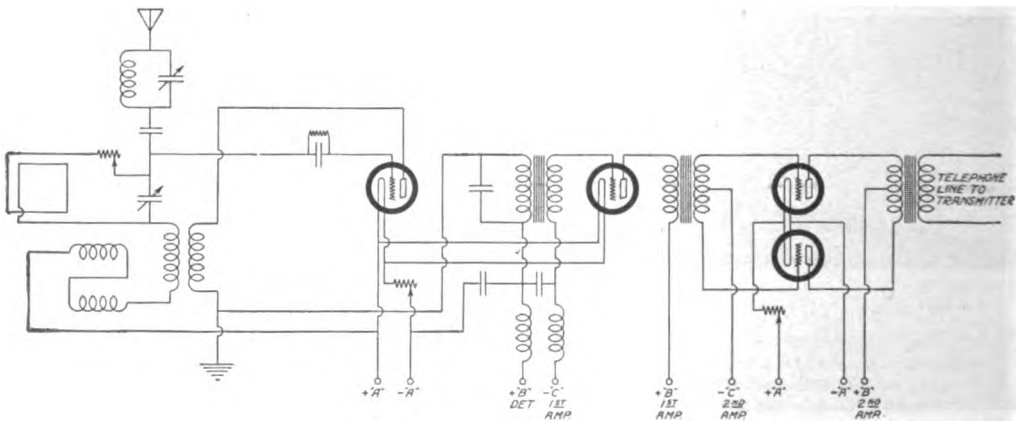
The range of frequencies necessary (or useful) in speech extends from some 30 or 40 vibrations a second up to about 6,000 vibrations a second; as the engineers say, the range is from 30 to 6,000 cycles. This is somewhat shorter than the perceptive range of the human ear, for many people can hear sounds down to 15 or 16 cycles and up to 20,000 cycles or even more. Some of these very deep and very shrill sounds are used in music, but they are not necessary to speech.

Dr. Fletcher's system of filters covers, however, the entire range of audio frequencies. They are divided into ten groups. The lowest-pitch group takes out all frequencies from zero to 125 cycles a second; the next removes the frequencies between 125 and 375 cycles; the third, those between 375 and 500 cycles, and so on. The tenth and last filter takes out all frequencies above 4,000 cycles, which is about the highest note used in ordinary orchestral music.

These filters can be used either separately or together, so that it is possible to remove from spoken sounds, or from music or any other sound, any desired group of frequencies, leaving the other frequencies to be heard alone.

When Dr. Fletcher connected these filters to a microphone circuit over which speech was passing and thence to a loudspeaker so that the audience could hear the result, some remarkable characteristics of speech became evident. For example, the intelligibility of speech is found to depend mainly on the higher frequencies, these being the frequencies that carry the consonants. When Dr. Fletcher adjusted his filters so that all frequencies below 1,500 cycles were filtered out, leaving only those from 1,500 to 6,000 and above, the speech was still quite intelligible, though nasal and unnatural in sound.

But when, on the other hand, the frequencies *below* 1,500 were retained, those above this limit being filtered out, the speech became a mere throaty grumble, possessed, it is true, of considerable volume, but totally unrecognizable as our familiar spoken English. When the one-end filtering was not extended so far, being confined, for example, to the loss of frequencies below 500 cycles or above 3,000 cycles, there was no interference with intelligibility but there was an unnaturalness of tone. The loss of the lower frequencies produced what we commonly call a "nasal" tone. The loss of the higher frequencies made the speech sound thick and hoarse.



RECEIVER HOOK-UP AT THE STATION KFKX

This receiver picks up the 94-meter wave from Pittsburgh. Note the loop that helps to balance out the local interference.

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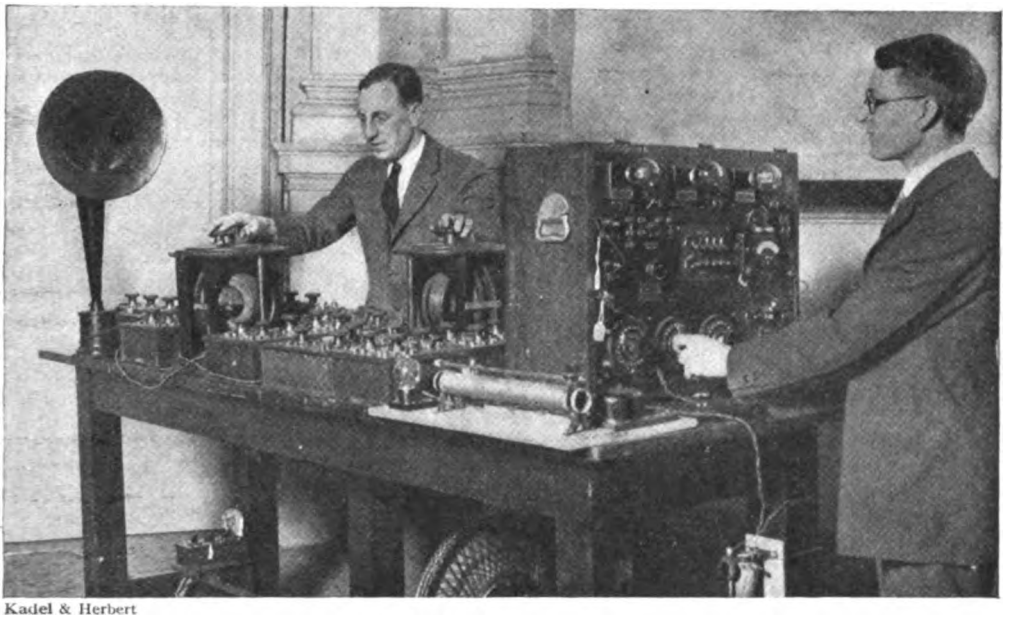

Kadel & Herbert

THIS MACHINE SAYS "PAPA" OR "MAMA"

Using this collection of vacuum tubes, wave filters and other apparatus, familiar to radio, Dr. Harvey Fletcher (at the right) and Dr. John C. Steinberg demonstrated to the New York Electrical Society their ability to produce sounds recognizable as spoken vowels, as well as the two words, "papa" and "mama."

Perhaps the most interesting of all these experiments to the radio fraction of Dr. Fletcher's audience was one in which *both* ends of the frequency series were filtered out, leaving, for example, only the middle range between a frequency of 375 cycles and one of 3,000 cycles. This produced a tone much resembling that of the usual types of loudspeaker used on radio sets. The implication, Dr. Fletcher explained, is exactly what it seems. Most of the loudspeakers now in use do actually filter out these higher and lower frequencies. The problem of producing a better loudspeaker reduces itself, therefore, to perfecting a device that will not filter out these extreme frequencies. Here will lie, we imagine, the greatest importance of Dr. Fletcher's detailed and original studies to the radio art.

An Amateur Radio Detective Tracks Down a Buzz

A RECENT exploit of Mr. Perry O. Briggs, 1BGF, deserves to stand as a model of how the radio amateur can help make his neighborhood a good neighborhood for radio.* It happened in Hartford, Connecticut, where a most annoying buzz showed up suddenly and interfered with reception on the outfits of many local listeners. Mr. Briggs agreed to track down the source of the trouble, loaded his receiver and an audibility meter into his automobile and went to work.

His first step was to occupy for brief intervals twenty-five separate receiving locations scattered over the city. At one of these locations the buzz was found to be substantially louder than at any of the others and the search was centered, therefore, in that neighborhood. With the set tuned in and the automobile moving slowly along the streets, Mr. Briggs hunted for the points of loudest buzz.

The troublesome locality was finally located on a short street that had but three street lamps and the interference was placed, with reasonable certainty, as some defect of the circuit lighting these three lamps. The Hartford Electric Light Company, being unable to locate the precise point of trouble, removed the whole wiring of the three lamps. Since then the buzz has been heard no more.

* "Cornering That Buzzing Interference," by Perry O. Briggs. *QST*, vol. 7, no. 8, pages 34-35 (March, 1924).

Radio Signalling with Live Frogs

A FRENCH scientist delving into the musty books of the great National Library in Paris, has discovered that an effect which we know now to be radio was discovered and described more than a hundred years ago.* The transmitter was a friction machine producing static

* "A French Pioneer in Radio," by T. Guinchant. *L'Onde Electrique*, vol. 2, pages 634-635 (November, 1923). The passage quoted from Biot is our own translation from a copy of his book in the Wheeler Collection in New York.

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sparks; the receiver (or, more precisely, the detector) was a live frog!

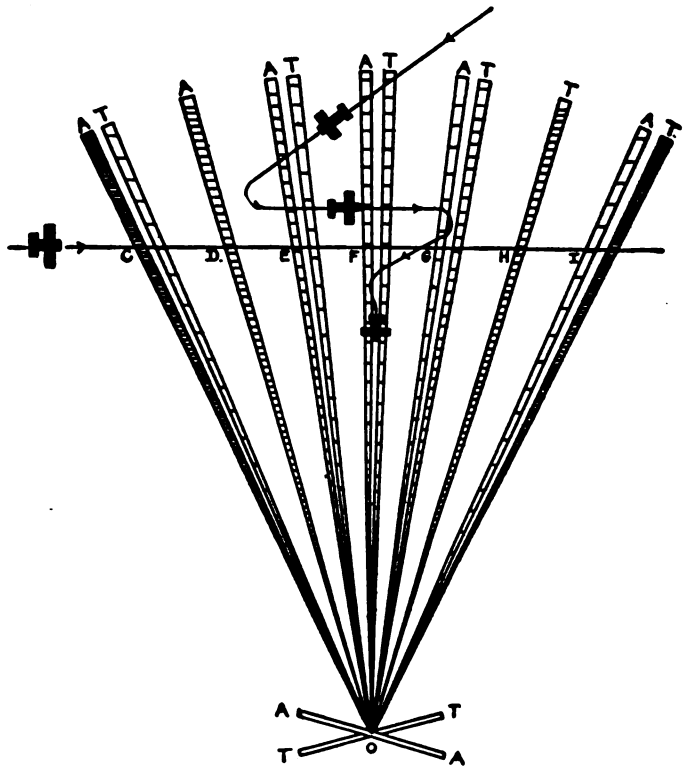
The genius who devised these experiments so much earlier than anyone had suspected an origin of radio was Jean Baptiste Biot, a French physicist who was well known to the scientific world in the days just following the adventurous years of the Revolution and of Napoleon. In 1819 he published in Paris his "Treatise on Experimental Physics and Mathematics." Here is how he described his experiments on what we now know to have been radio:

"Suspend a living frog by a silk cord, at some distance from the conductor of an electric machine and attach to one of the legs of the frog a light and flexible metallic chain, the lower end of which makes contact with the ground. Then, whenever you operate the machine, as the electricity develops on it sparks will escape from time to time from the conductor, especially if you present to this conductor a metal rod with a hemispherical end. At each explosion of the spark you will see the frog jump, even though it is not in communication with the electric circuit."

Biot goes on to say that this experiment can be performed even with a dead frog, provided that it has been properly prepared, and he adds an observation which, in the light of our present knowledge, is especially interesting. "The muscular contractions may be produced," he says, "even at a distance of ten or twelve meters."

There can be no doubt that this ingenious Frenchman, working with sparks and frogs long before anything was known of the nature of electricity, to say nothing of electric waves, really had his hand upon the phenomenon of energy transfer by electromagnetic waves—a phenomenon that it took science over seventy years to rediscover.

It is of interest, also, that the "frog detector" can still be employed with radio waves. A modern French scientist has been able, says Biot's recent rediscoverer, to detect the time signals from the Eiffel Tower, using a frog in much the same way that Biot employed.



Reprinted from Scientific Paper No. 480 of the U. S. Bureau of Standards

HOW AN AIRPLANE IS GUIDED BY THE NEW RADIO SIGNAL SYSTEM

The radio signals are sent out from the two coils shown at the bottom of the diagram, as described on the following page. So long as the airplane flies along the line marked F, the two letter-signals are heard with the same intensity. To the right or left of this line, one letter or the other is stronger.

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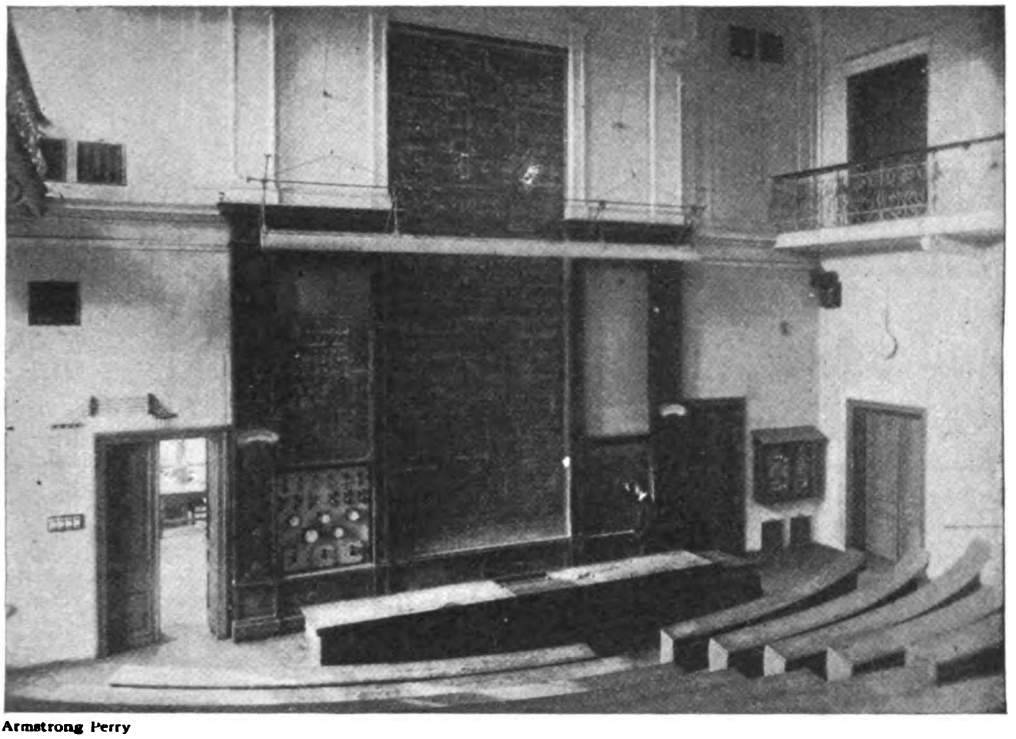

Armstrong Perry

A REAL "RADIO LECTURE ROOM"

In this recitation hall of the Electrotechnical Institute in Vienna, Austria, all kinds of electric current are supplied at the desk, the blackboard is operated automatically and there is a special screen of ground glass for use with the oscillograph.

A New Radio Pathfinder for Airplanes

By means of a new invention, developed at the United States Bureau of Standards, it is now possible for an airplane to fly from one flying field to another one, or to fly, for that matter, along any determined air lane, and never deviate in the least from the direct line of flight. This can be done even in the thickest fog or if the pilot is blind. It is done by a new sound signal that comes to the pilot over the radio.*

At the flying field or other station toward which the airplane is flying there are two vertical coil antennas, their planes being placed at an angle of 135 degrees to one another. The transmitting set is connected alternately first to one coil, then to the other. One coil sends out the code signal for the letter A, the other coil sends out the letter T. All this can be attended to automatically, the change from one coil to the other being made, also automatically, every second.

Like all loop antennas these coils have directional properties, the signals which they send out being stronger in the plane of the coil than in any other direction. And therefore, since two coils are used in this case, there is a certain direction with reference to the positions of the coils in which direction the relative signal strength of the two letters, A and T, is the same. In any other direction one of the letters will seem to the aviator louder than the other one.

Suppose it is desired to guide an airplane between New York and Philadelphia: The coils are erected at Philadelphia and their position is adjusted so that the line of equal signal strength of the two letters points directly toward New York. Then let the aviator in New York take off and head, as he believes, toward Philadelphia. So long as he really does head toward Philadelphia, so long, that is, as his machine is close to the straight line between the two cities, he will hear the A's and T's in his headphones with exactly the same strength. But suppose he accidentally deviates from this straight line? Then he will hear one of the letters louder than the other. All he has to do is to keep his plane in that position where the two letters sound alike and he will arrive, without further attention on his part, at the station from which the signals are being sent out.

* "A Directive Type of Radio Beacon and Its Application to Navigation," by F. H. Engel and F. W. Dunmore. *Scientific Papers of the Bureau of Standards*, number 480 (being vol. 19, pages 281-295), January 5, 1924.

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CONDUCTED BY KENDALL BANNING

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Practical Hints on the Care of Radio Panels

A NEAT looking panel is an important factor in a radio installation. A set may approach perfection electrically yet give a poor impression because of a greasy or spotted panel. How to keep your panels clean is told by this reader from Oregon:

Radio panels can be divided into two classes, those with a polished surface, such as are generally used in receiving equipment, and those with a dull finish, such as slate, composition, fibre, or any of the resinous materials; sometimes rubber or similar products.

The type with polished surfaces quickly become marked, particularly in receiving sets, where the operator's fingers often come into contact with the panel when tuning. Such a panel should be rubbed over with a soft cloth occasionally to remove any spots that may appear on its surface. Even with this care, however, one finds that all of the dirt or grease that may accumulate cannot be entirely removed; the most effective method of cleaning then is to rub down the panel with a rag saturated in alcohol, finishing off with a soft, dry cloth.

If the panel is not unduly exposed to dust and dirt the cloth used for frequent cleaning may be used with a few drops of raw oil. This brings out a brilliant lustre on the polished surface without injuring the panel in any way.

The type of panel that has a dull or mat finish, does not show the dirt so easily as the type with a polished surface. Many amateurs and fans who construct their own apparatus prefer this type of finish. An occasional rub-down with an oily rag, using raw oil in small amounts, keeps the dull finished panels looking neat.

Slate panels, generally used on shipboard for switchboards, charging panels or starting devices are best cleaned with an ammonia solution. These panels should be gone over whenever the bright work on them is polished, as some metal polish is frequently left on the slate, turning that particular spot lighter than the rest and detracting considerably from the generally good appearance of the panel.

A few pointers on the working of panels in the construction of radio sets may be of help to those who experience difficulty in making these up:

A center punch should be used for laying out all holes. A spring prick-punch is preferable for this.

In drilling holes, begin to drill from the front side, clamping the panel to a board or to a bench to avoid chipping. Use *sharp* metal twist drills.

To countersink a hole, use a reamer or a larger size of drill.

In polishing a panel for the first time use steel wool or sandpaper and raw linseed oil for surfacing. Follow this with a thorough rubbing down with pumice and oil, and then finish off with a few drops of oil and a clean, soft cloth.

—THERON W. BEAN

Stations You May Hear from Canada and Cuba

SUPPLEMENTING the list of American broadcasters in the January issue of POPULAR RADIO, and the list of European stations in the December, 1923, issue, here is a complete list of the stations now on the air with broadcast programs in Canada and Cuba:

CANADIAN STATIONS

Call Letters	*Location of Station*	*Wave-length (meters)*	*Freq. (kilo cycles)*
CFAC	Calgary, Alberta	430	698
CFCA	Toronto, Ont	400	750
CFCP	Montreal, P. Q.	440	682
CFCH	Iroquois Falls	400	750

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Call Letters	Location of Station	Wave length (meters)	Freq. (kilo-cycles)
CFCJ	Quebec, P. Q.	410	732
CFCK	Edmonton, Alta.	410	732
CFCL	Victoria, B. C.	400	750
CFCN	Calgary, Alberta	440	682
CFCO	Bellevue, P. Q.	450	667
CFCQ	Vancouver	450	667
CFCR	Sudbury	410	732
CFCW	London, Ont.	420	714
CFDC	Nanaimo, B. C.	430	698
CFQC	Saskatoon, Sask.	400	750
CFRC	Kingston, Ont.	450	667
CFUC	Montreal	400	750
CHAC	Halifax, N. S.	400	750
CHBC	Calgary	410	732
CHCD	Quebec	410	732
CHCE	Victoria	400	750
CHCL	Vancouver	440	682
CHYC	Montreal	410	732
CJCA	Edmonton, Alberta	450	667
CJGC	London, Ont.	430	698
CJCD	Toronto	410	732
CJCE	Vancouver	420	714
CJCI	St. John, New Brunswick	400	750
CJCN	Toronto	410	732
CJCX	Olds, Alta.	400	750
CJSC	Toronto	430	698
CKAC	Montreal	430	698
CKCD	Vancouver	410	732
CKCE	Toronto	450	667
CKCK	Regina, Sask.	420	714
CKOC	Hamilton, Ont.	410	732
CKY	Winnipeg	450	667

Cuban Stations

Call Letters	Location of Station	Wave-length (meters)	Freq. (kilo-cycles)
PWX	Havana	400	750
2AB	Havana	240	1,250
2BY	Havana	260	1,154
2CX	Havana	320	938
2DW	Havana	300	1,000
2EV	Havana	220	1,364
2HC	Havana	275	1,091
2HS	Havana	180	1,667
2JQ	Havana	150	2,000
2KD	Havana	350	854
2KP	Havana	200	1,500
2LC	Havana	250	1,200
2MG	Havana	280	1,071
2MN	Havana	270	1,111
2OK	Havana	360	833
2OL	Havana	290	1,034
2TW	Havana	230	1,304
2WW	Havana	210	1,428
5EV	Colon	360	833
6AZ	Cienfuegos	200	1,500
6BY	Cienfuegos	300	1,000
6CX	Cienfuegos	170	1,765
6DW	Cienfuegos	225	1,333
6EV	Caibarien	225	1,333
6KJ	Tuinucu	275	1,091
6KW	Tuinucu	340	882
8AZ	Santiago	240	1,250
8BY	Santiago	250	1,200
8DW	Santiago	275	1,091
8EV	Santiago	180	1,667
8FU	Santiago	225	1,333

Wide World

RECORDING RADIO PROGRAMS ON A WAX CYLINDER

Here is the new "radio telephone" that registers automatically all the incoming entertainment that the radio receiver is tuned in upon; the cylinder records may be preserved and the programs repeated upon the talking machine. This novel device is the product of a German inventor.

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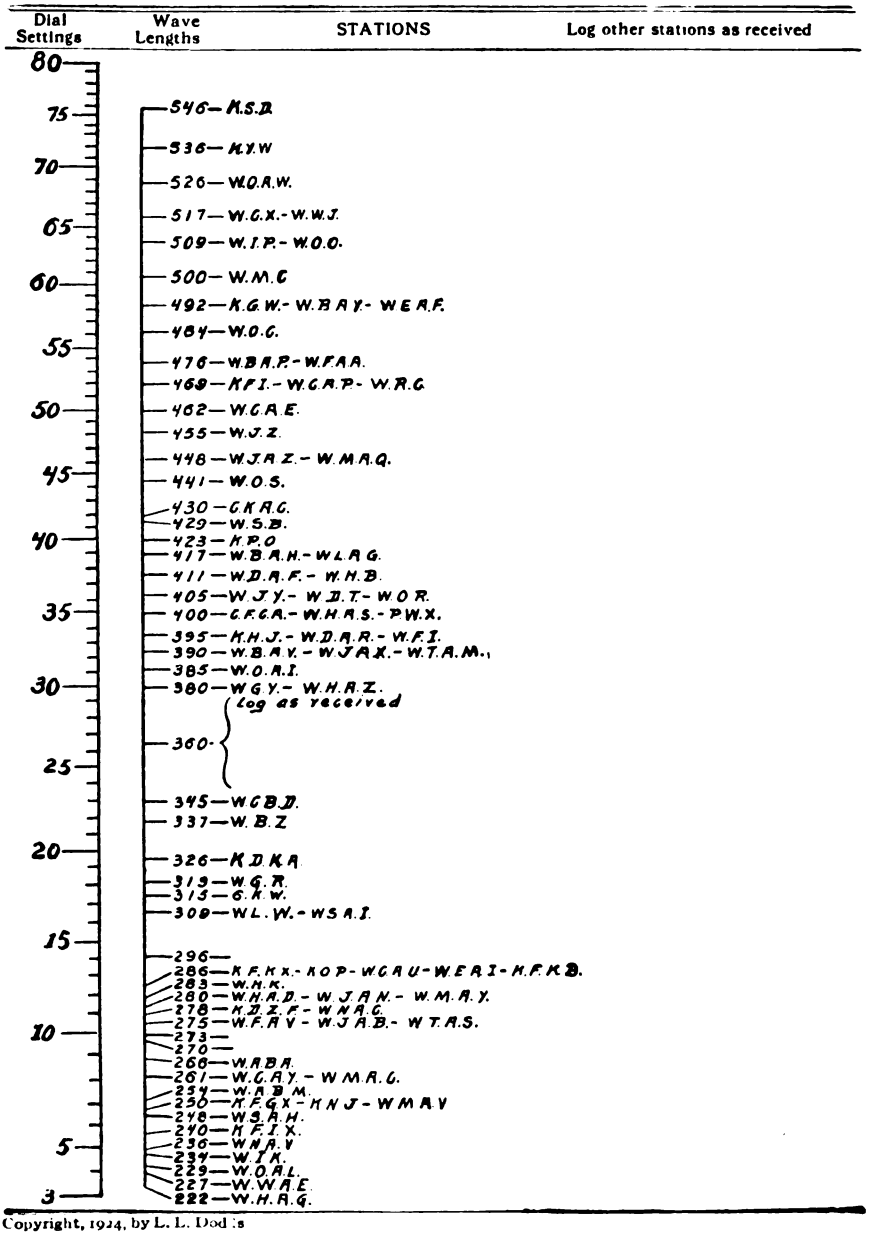
A Straight Line Chart for Tuning a

FOUR-CIRCUIT COCKADAY RECEIVER



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CHARTS THAT HELP YOU TO TUNE IN

The charts on these two facing pages were designed to suit theoretical, ideal construction conditions of each particular circuit; as actual conditions vary from the ideal in individual receiving sets, the wavelength and dial-setting scales have been separated by a blank column, which provides ample space to connect the wavelength of any station tuned in, with the dial setting at which the signals come in loudest and clearest; for example, if you tune in W G Y with your dials set at 33, you should connect 33 on the left-hand scale with 380 on the right-hand scale, by a straight line.

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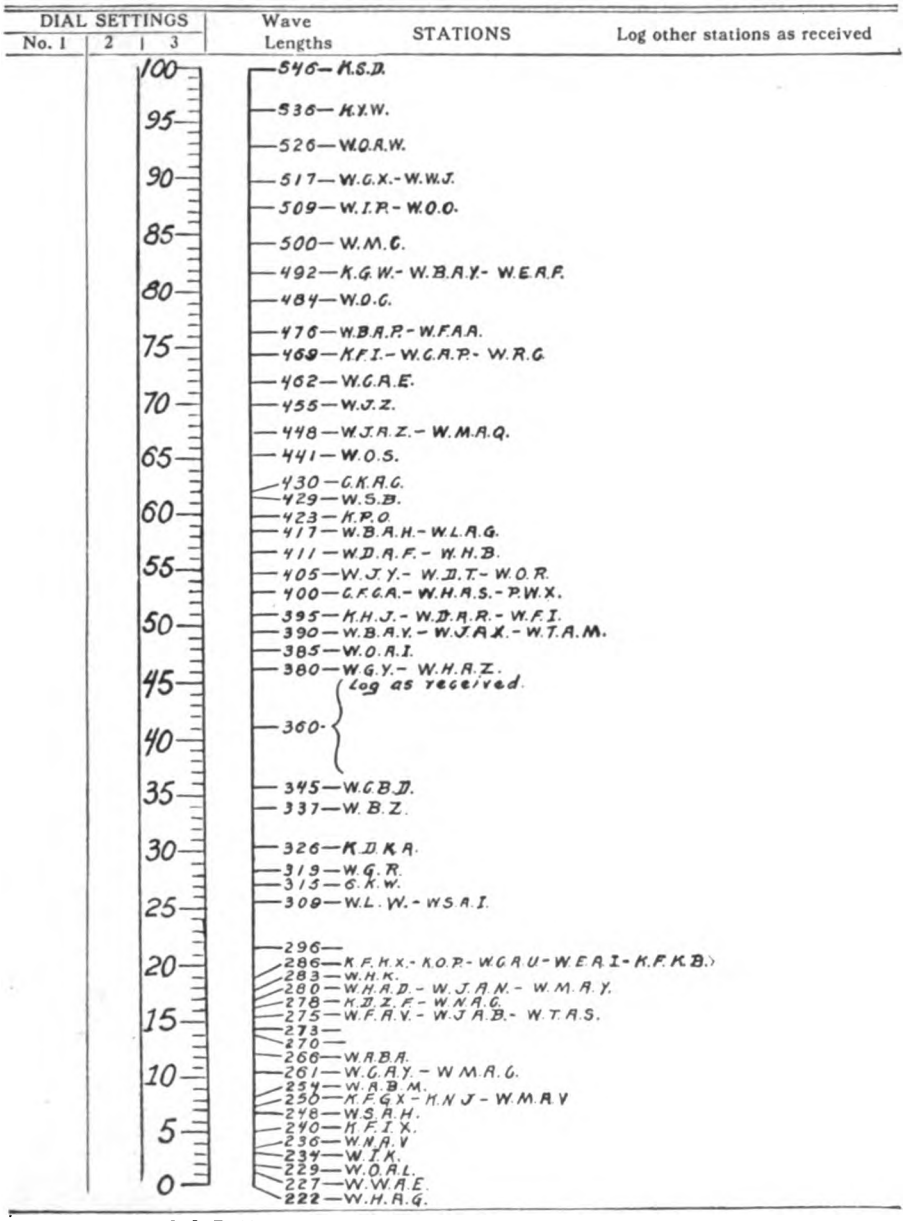
A Straight Line Chart for Tuning a

NEUTRODYNE BROADCAST RECEIVER



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HOW TO USE THIS CHART

After tuning in a station sharp and clear, enter the No. 1 and 2 dial settings; then draw a straight line from the dial setting to station's wavelength. This list includes all wavelengths for stations of 200 watts and over and call letters of all stations of 500 watts and over—excepting those on 360 meters, which are omitted on account of the large number, and a few of which may be heard in any particular district.

The calibration of the dial scale is graduated by a special mathematical process evolved by Mr. L. L. Dodds, of Cleveland, O.

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Better Results with Less Power

AMERICAN amateurs are today communicating with English amateurs with one thousandth of the power used with indifferent results twenty years ago, states J. T. H. Dempster, an engineer. To be specific:

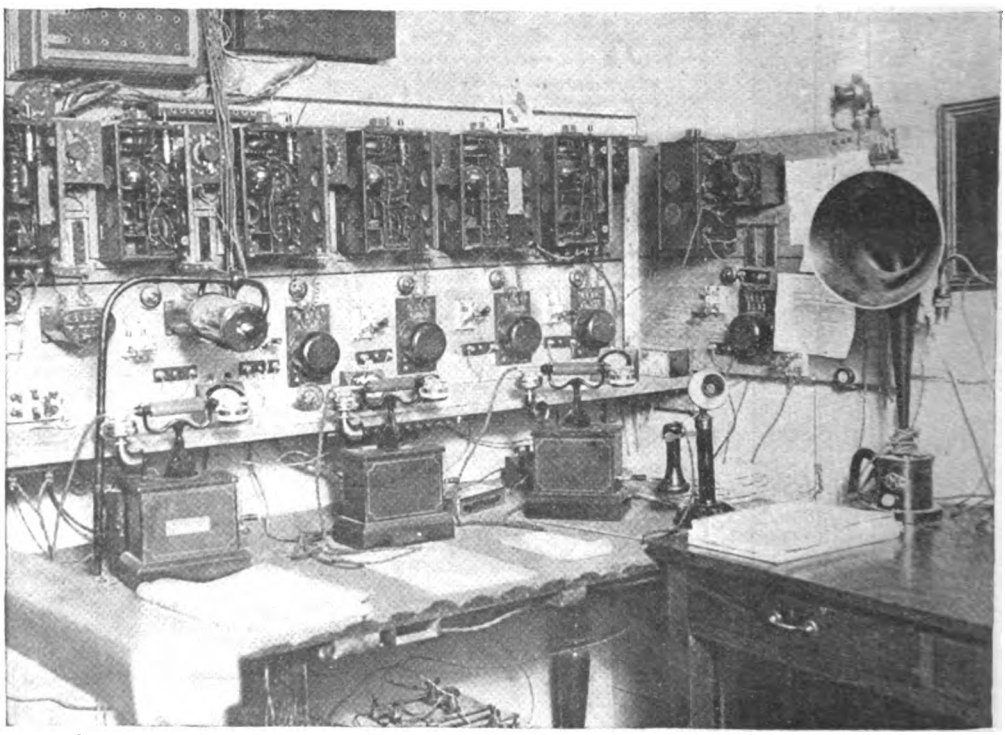
Back in 1904, a few years after Marconi startled the scientific world with his experiment that promised to revolutionize long distance communication, the General Electric Company engineers were actively interested in the new art and they, like others, tried for a long time to offset the shortcomings of receiving apparatus by boosting the power at the transmitting end. Dr. R. A. Fessenden, formerly a professor at the University of Pittsburgh, was engaged to install transmitting and receiving equipment, with the expectation that this method of communication would replace the telephone and telegraph lines.

The receiving apparatus consisted of the famous Fessenden liquid barretter or, in better known terms, the electrolytic detector, which was used in connection with the Fessenden interference-preventer circuit. The electrolytic detector consisted of a platinum wire coated with silver. This was known as "Wollaston wire." The silver coating gave mechanical strength to the wire which was less than ten thousands of an inch in diameter. The nitric acid in a platinum cup into which the wire dipped formed the electrolyte. The platinum cup was the other pole of the electrolytic cell.

The electrolytic detector was a marked advance over the Marconi coherer but it was still much less sensitive than the crystal detectors now in use. Static frequently burned the point from the platinum wire temporarily destroying the use of the detector.

The headphones adopted were especially made according to the navy standard and they were wound for the first time with enameled wire. These phones were about one twenty-fifth as sensitive as the cheapest headphones on the market today.

Today, an operator in Lynn with a three-bulb receiving set can get Schenectady signals 1,000 times stronger than was possible in 1903 and that from a transmitter using but five watts and a mast fifty fee high.



Kadel & Herbert

HAVE *YOU* HEARD THIS ENGLISH STATION?

Here is shown some of the line equipment that is used for picking up programs from points outside the studio in the London broadcasting station, 2LO. This equipment includes vacuum-tube amplifiers (which are shown mounted on the wall in boxes), and also the regular telephone apparatus for listening in and testing out the lines in use.

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If you are getting good results with your receiving set, tell your fellow-readers of POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

REINARTZ HAS ANOTHER ADMIRER

THE Reinartz hook-up is praised by J. Sulouff of Altoona, Pa., who submits the following list of stations logged in four evenings: WEAF, New York City; WIP, WDAR, WFI, WOO, Philadelphia, Pa.; WGR, Buffalo, N. Y.; WGY, Schenectady, N. Y.; KDKA, Pittsburgh, Pa.; WGAW, Altoona, Pa.; WCR, Washington, D. C.; WSB, Atlanta, Ga.; WHAS, Louisville, Ky.; WOR, Newark, N. J.; WCAE, Pittsburgh, Pa.; WMC, Memphis, Tenn.; WOC, Davenport, Ia.; WGI, Medford Hillside, Mass.; WWJ, Detroit, Mich., and WDAP, Chicago, Ill.

* * *

A CRYSTAL RECORD

NICK MANFREDI of 30 Van Houten Street, Paterson, N. J., makes bold enough to say that he receives PWX of Havana, Cuba, on his crystal set.

Others on his list are KDKA, Pittsburgh, Pa.; WGI, Medford Hillside, Mass.; WGY, Schenectady, N. Y.; WOC, Davenport, O., and PWY of Havana, Cuba.

* * *

HOW IT SOUNDS IN ENGLAND

STATIONS WGY and WJZ can be heard in England on three tubes, one radio-frequency, one detector and one audio-frequency, according to Bernard Caldwell of station 5VK in Warrington, Lancashire. That is to say in American terminology, he hears these two New York stations in the early morning with one stage of radio and one stage of audio-frequency amplification. He uses a single-wire antenna 35 feet high and 90 feet long.

"I sometimes receive complete programs, without any sign of fading, between the hours of two and five in the morning," he explains, "and I have letters from the General Electric Company and from the Westinghouse Electric Company in confirmation."

COCKADAY SET SPANS ATLANTIC

USING only one tube, three stations in the British Isles were heard on the Cockaday four-circuit tuner by Edward W. Kent, whose address is Box 263, North Sydney, Nova Scotia, Canada, "1,000 miles from anywhere and 3,500 miles from KFI," Los Angeles, Calif., which he also heard.

His only variation from the plans described in POPULAR RADIO was to use an English Mullard tube. His antenna, as suggested, was made longer than usual, about 195 feet from the set to the end, and about 40 feet high, with a counterpoise of 175 feet of bare copper wire, number 6, buried one foot deep directly under the antenna.

He says he has heard amateurs in every district in the United States, three in Canada and one in England.

Some of his record broadcasters are KHJ, Los Angeles, Calif.; WOAW, Omaha, Nebr.; WSB, Atlanta, Ga.; WFAA, Dallas, Tex.; WKAQ, San Juan, Porto Rico; PWX, Havana, Cuba, and WOC, Davenport, Ia. There are 120 others.

"WGY comes in so strong, a thousand miles away, that the phones rattle," he states. "On particularly good nights I can hear it fifteen feet from the phones."

* * *

DISTANCE IS A REGULAR THING

"I HAVE been receiving from KHJ, Los Angeles, every night since October 13, using your four-circuit tuner," is the news from Wilmerding, Pa., where S. K. Yundt, Jr., is trying a few tricks of his own.

"Use WD-11 tubes throughout and Cardwell condensers, with a 250-foot antenna about 50 feet high," is Yundt's prescription for success. Add to this a condenser of .00015 mfds. capacity, a rather critical thing, across the phones and make your coils without fluid covering of any kind.

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WHAT THE REINARTZ CIRCUIT CAN DO

A RECORD of hearing thirty-eight stations more than 1,000 miles away is submitted by Carl H. Pastje of Denison, Ia. He does it with a Reinartz coil and two stages of audio-frequency amplification. By using a UV-200 detector tube and UV-201A amplifier tubes, he brings in most of the stations on a loud-speaker.

On the coil he is using, there are only 14 taps. His condensers are 23-plate and 43-plate vernier type, and his transformers are RCA 9 to 1 in the first stage and Thordarson 3½ to 1 in the second stage. The antenna consists of one strand of number 12 copper wire supported between two wooden masts at an average height of 45 feet, with two insulators at each end. Ground connection is made to a telephone ground rod 7 feet long and ⅝ of an inch in diameter, driven into moist earth.

The list includes WKAQ, San Juan, Porto Rico, 2,450 miles away; KPO, San Francisco, Calif., 1,525; PWX, Havana, Cuba, 1,575; KDZE, Seattle, Wash., 1,435; KGG, Portland, Ore., 1,465; WEAF, New York City, 1,150; KFAN, Moscow, Idaho, 1,180; KFCB, Phoenix, Ariz., 1,125; WJAR, Providence, R. I., 1,265; WHAO, Savannah, Ga., 1,065; WHAV, Wilmington, Del., 1,080 and, WDAL, Jacksonville, Fla., 1,150.

* * *

HE PULLS IN 67 SPEAKER STATIONS

H. E. MUELLER of Pilot Grove, Mo., hears 67 stations on his loudspeaker "with enough volume to fill a good-sized room." He uses the Cockaday four-circuit tuner. His record speaker station is CYB of Mexico City, Mex. Others are WSY, Birmingham, Ala.; CFCN, Calgary, Can.; KLZ, Denver, Colo.; WBAP, Ft. Worth, Tex.; WHAB, Galveston, Tex.; KFKA, Greeley, Colo.; PWX, Havana, Cuba; KHJ, Los Angeles, Calif.; WMC, Memphis, Tenn.; WEAF, New York City; WAAC, New Orleans, La.; WHAM, Rochester, N. Y.; WOAI, San Antonio, Tex.; WLAL, Tulsa, Okla., and WJAD, Waco, Tex.

* * *

SET REACHES TWELVE STATES IN FOUR HOURS

IN one evening in Chicago, Wm. B. Metcalf, Jr., heard seventeen stations in twelve different States with his Cockaday four-circuit tuner. He writes that most of them were heard on a loudspeaker.

The stations he heard are KDKA, Pittsburgh, Pa.; WWJ, Detroit, Mich.; WOC, Davenport, Ia.; WGY, Schenectady, N. Y.; WLW, Cincinnati, O.; WGR, Buffalo, N. Y.; WTAS, Elgin, Ill.; WCBD, Zion, Ill.; WOS, Jefferson City, Ia.; WMC, Memphis, Tenn.; WHAZ, Troy, N. Y.; WOAW, Omaha, Nebr.; WFAA, Dallas, Tex.; WBAP, Ft. Worth, Tex.; WLAG, Minneapolis, Minn.; WSB, Atlanta, Ga.; WDAF, Kansas City, Mo.

Through the local stations he heard KDKA, Pittsburgh, Pa.; KSD, St. Louis, Mo.; WBAP, Ft. Worth, Tex.; WFAA, Dallas, Tex.; WSAI, Cincinnati, O.; WOC, Davenport, Ia., and WOAW, Omaha, Nebr.

HE DOES THIS IN DAYLIGHT

ANOTHER mystery similar to that of the "fading" of WGY, Schenectady, and the "dead spots" of WEAF, New York, and similar freaks of other stations, is reported by F. P. Morrow, of Arnaudville, La. Some near-by stations he cannot hear at all, while he receives unusually well from other stations during the day.

"I am in a very small town," he writes, "away from any large city, and there are no powerful broadcasting stations near me, except one 100-watt station in Baton Rouge, 60 miles away, and stations of similar power in New Orleans. For some queer reason I am unable to hear these stations at any time, on my four-tube set.

"I get the weather report every morning from WHAB, a 200-watt station at Galveston, Tex., and from WCAK at Houston, Tex., a 10-watt station 215 miles away.

"I listen in on the Normal Teachers' School at Cape Girardeau, Mo., at three o'clock in the afternoon. Last Sunday afternoon at 3:30, I heard WTAS, Elgin, Ill., and now, at 4:00, I get WHAS at Louisville, Ky., and KDKA at Pittsburgh, Pa. Most other powerful stations in the southern part of the country come in well at night."

* * *

ONE EVENING'S TRAVEL

SIXTEEN stations in one evening, using a dry-cell tube, is the record of Franklin Wernli of Minneapolis, Minn. He uses only a vario-coupler and a 23-plate variable condenser for tuning. For DX hunting, his single-circuit hook-up is one of the simplest, but for sharp tuning and clear reception without interference, the double circuit is always better.

On the night of September 21, he heard WCAE, Pittsburgh; WWJ and WCX, Detroit, Mich.; WOAW, Omaha, Nebr.; WJAZ, Chicago; KSD, St. Louis, Mo.; WSAI, Cincinnati, O.; KYW, Chicago; WSB, Atlanta, Ga.; KFI, Los Angeles, Calif.; WMC, Memphis, Tenn.; WMAK, Lockport, N. Y.; WDAF, Kansas City, Mo.; WHN, New York City; WFAG, Syracuse, N. Y.; KGW, Portland, Ore.

* * *

HE IMPROVES HIS COCKADAY SET

THE wrong coil was all that was keeping his Cockaday four-circuit tuner from spanning the continent, according to Joseph Waring of 441 East 164th Street, New York. When he replaced his first coil with one which is specified for the circuit, he picked up Los Angeles, Calif.

"At twelve-fifteen I tuned in Station KHJ of Los Angeles," he writes, "and held it continually until one-thirty A. M., and am delighted to say that I experienced no fading or interference. I consider this good, because I was using only one WD11 tube.

Others which he heard with his little dry cell are WJAZ of Chicago, Ill.; WOC, Davenport, Ia.; WCX, Detroit, Mich.; WSB, Atlanta, Ga.; WRK, Hamilton, O., and WCAP, Washington, D. C. This is a partial list for his first evening with the new coil.

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CONDUCTED BY THOMAS ELWAY

THIS *department will keep you in touch with the latest inventions of interest on which patent rights have been granted, and which are significant contributions to radio art.*

Static Eliminator

No. 1,468,049. *Invented by A. H. Taylor of Grand Forks, North Dakota, and assigned to the Radio Corporation of America.*

This is a method of making a partial separation between signal impulses and static or other strays by using two or more antennas, one of which is more receptive to the signals while the others are more receptive to strays. The antennas are then opposed electrically so that the effect of the strays in the signal-receiving antenna is more or less neutralized. Detailed arrangements of circuits and antennas for this purpose are described and covered by the patent.

Removing Vertical Strays

Nos. 1,468,059 AND 1,468,061. *Invented by R. A. Weagant of Douglas Manor, New York, and assigned to the Radio Corporation of America.*

These patents are applications of a theory formulated by the patentee to the effect that the impulses of static are mainly vertical, while the signal impulses that one wishes to receive are mainly propagated horizontally. Circuits are arranged to receive selectively the up-and-down waves of static and to oppose these to the impulses in ordinary antennas, thus balancing out the effects of static in the latter.

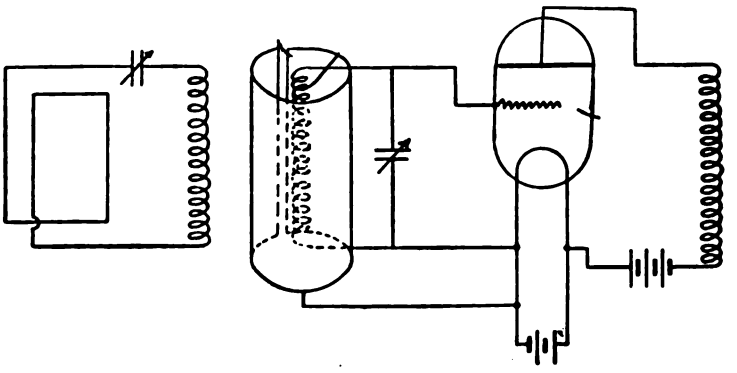
Shielded Transformer Winding Decreases Interference

No. 1,474,382, FIGURE 1. *Invented by H. J. Round of London, England, and assigned to the Radio Corporation of America.*

A metal sheet is bent into cylindrical form, but so that its edges do not quite touch, as is shown in the illustration. This partial shield is then placed around the secondary of the coupling transformer, which secondary is so wound that its self-capacity is a minimum. This arrangement is said to greatly decrease interference from short waves, as for example, interference from the engine ignition in airplane radio.

Magnetic Mounting for Catwhisker

No. 1,475,027, FIGURE 2. *Invented by E. F. Randall of Medford, Massachusetts, and as-*



A SHIELD FOR SHORT WAVES

FIGURE 1: *The metal shield around the secondary of the transformer cuts out much of the interference from the ignition systems of gasoline engines.*

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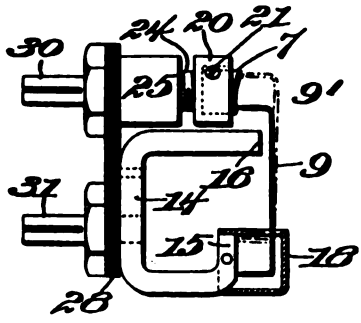


MAGNETIC CATWHISKER

FIGURE 2: *The magnet, 14, holds the catwhisker, 9, against the surface of the crystal, 7. The catwhisker is loose and may be moved up and down to get adjustment, being held in place thereafter by the magnet.*

signed to the American Radio and Research Corporation.

The nature of this device will be apparent from the figure. The catwhisker is made of magnetic material and its point is held firmly against the crystal by the pull of the permanent magnet mounted just beneath it. The detector is said to be less sensitive to jar than are ordinary crystal detectors. The patentee believes, also, that the magnetic field of the magnet assists detection in some more direct fashion; which, if true, is a new effect hitherto unknown.

A Commutator for Antenna Circuits

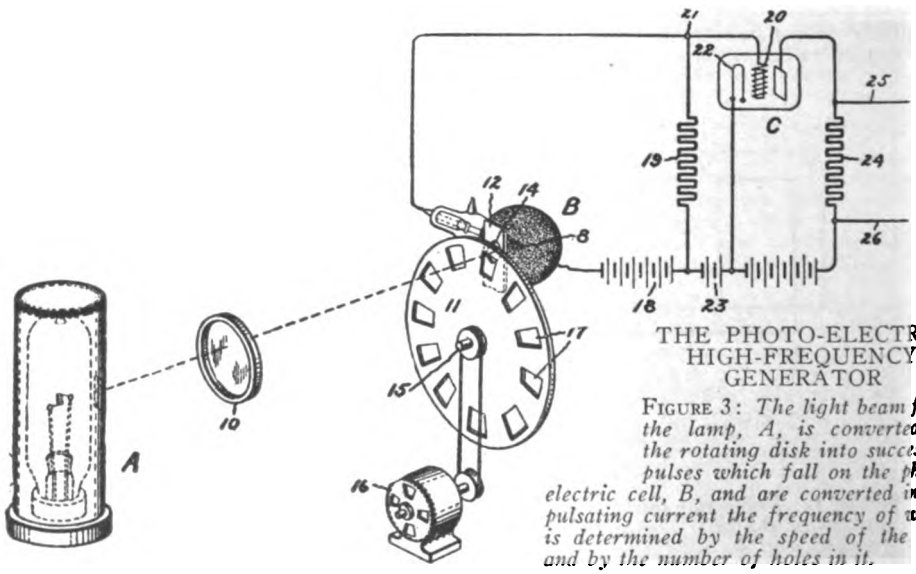
No. 1,475,297. *Invented by Robert B. Goldschmidt of Paris, France.*

The patentee suggests that unwanted signals can be blocked out of a receiving circuit by inserting between the antenna and the receiver a rotating contact wheel analogous to the commutator of a dynamo. Suppose, for example, that the signal consists of a wave train interrupted to give a frequency of 500 cycles. The wheel is then adjusted to connect and disconnect the antenna at this same frequency. It is necessary, obviously, that the synchronism of the sending and receiving stations be perfect and the device is apparently limited to telegraphy and to the transmission of radio-control signals, being without obvious application to radio telephony.

Light Beam Produces Audio-frequency Oscillations

No. 1,475,583. FIGURE 3. *Invented by Charles A. Hoxie of Schenectady, New York, and assigned to the General Electric Company.*

This apparatus generates a pulsating or alternating electric current of any predetermined frequency by means of a beam of light, a perforated disk that rotates across this beam, and a photo-electric cell. Each pulse of light through a hole of the disk causes a pulse of electricity in t e cell, which pulse may be amplified by a vacuum tube, as shown in the diagram. The photo-electric cell used consists of a coating of metallic potassium inside a vacuum bulb containing a little argon gas. Light falling on the potassium sets free some electrons from it and these electrons produce the pulse of current. When no light falls on the potassium in the cell, that is when the dark part of the disk is in front of it, no electrons are set free and no current passes. A somewhat similar arrangement used by General Ferrié to measure the intensity of starlight was described in POPULAR RADIO for April, 1924, page 408.



THE PHOTO-ELECTRIC HIGH-FREQUENCY GENERATOR

FIGURE 3: *The light beam from the lamp, A, is converted by the rotating disk into successive pulses which fall on the photo-electric cell, B, and are converted into a pulsating current the frequency of which is determined by the speed of the disk and by the number of holes in it.*

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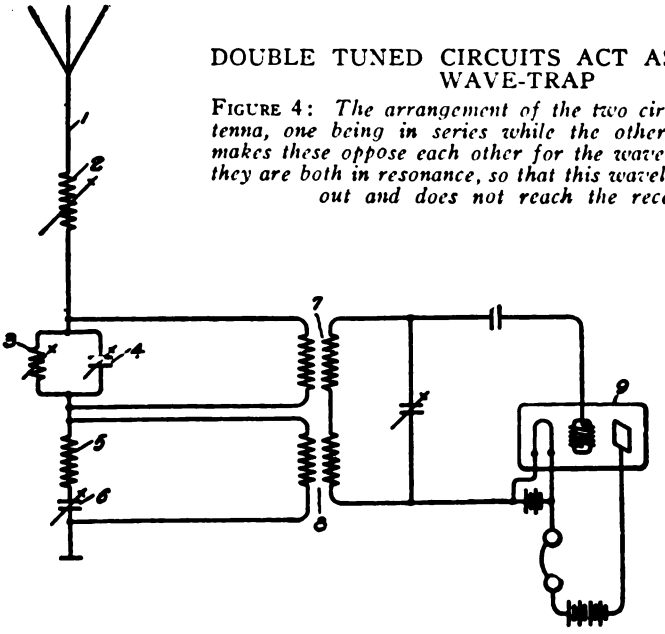


DOUBLE TUNED CIRCUITS ACT AS ANTENNA WAVE-TRAP

FIGURE 4: *The arrangement of the two circuits in the antenna, one being in series while the other is in parallel, makes these oppose each other for the wavelength to which they are both in resonance, so that this wavelength is filtered out and does not reach the receiver.*

Circuit Breaker for Overloaded Antennas

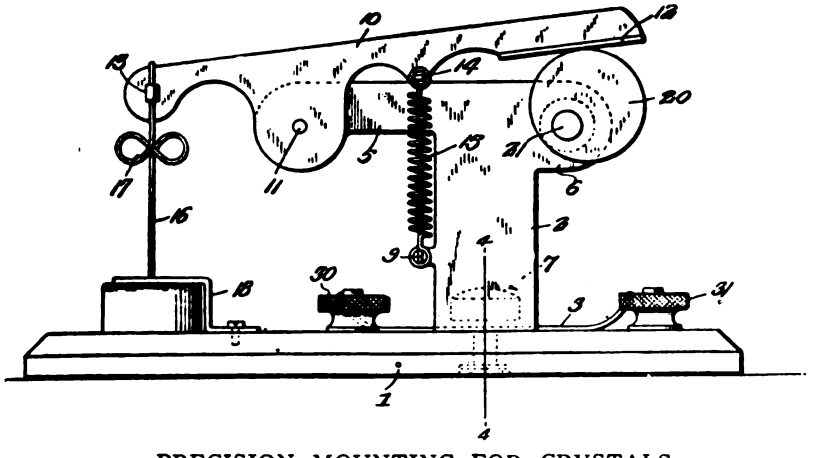
No. 1,475,632. *Invented by Harold B. Herty of New Orleans, Louisiana.*

When a receiving antenna is close to a powerful transmitting antenna the currents generated in it are sometimes too strong for safety. This device inserts in the antenna circuit a thermal relay, so arranged that if it becomes warm from an overload the current produced in the relay circuit operates a switch and grounds the antenna through a low-resistance metallic circuit, thus saving the coupling coils and the receiving set.

Doubly Tuned Antenna to Trap Unwanted Waves

No. 1,477,413, FIGURE 4. *Invented by E. F. W. Alexanderson of Schenectady, New York, and assigned to the General Electric Company.*

The problem of operating a receiving antenna close to a powerful transmitter operating on another wavelength is met, in this invention, by a double tuning in the antenna circuit; one tuning having its capacity and inductance in parallel, the other having them in series, as is clear from the figure. The values of the capacities and inductances in these two connected circuits are so adjusted that, for the



PRECISION MOUNTING FOR CRYSTALS

FIGURE 5: *The cam, 20, mounted on the axis, 21, permits the precise raising or lowering of the catwhisker, 16. This cam may be turned by a knurled knob on the extension of the axis, 21. A proper tension is provided by the spring, 15.*

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wavelength which it is desired to tune out, the pick-ups in the coupled circuits are equal and opposite. Therefore, the interference from this wavelength is blocked out. For other wavelengths the voltage-drops across the two tuned circuits in the antenna diverge; one circuit becoming (effectively) a capacity, the other an inductance. The coupled circuits do not then cancel each other and the signal is detected.

Precision Adjustment for Crystal Detector

No. 1,477,826, FIGURE 5. *Invented by Robert J. Heitzman of Union Hill, New Jersey.*

This invention represents another attempt to solve the problem of a stable adjustment between the catwhisker and the crystal. A combination of springs, cams and levers permits the precise placing of the metal point on the crystal surface, not only with regard to the position of the point but also with regard to its exact pressure of contact.

Artificial Transmission Line for Selective Reception

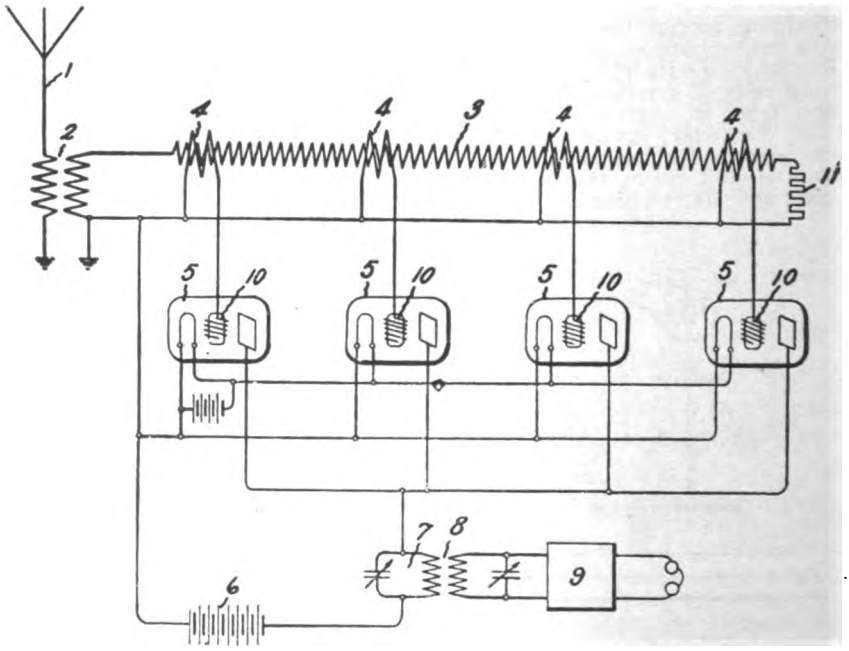
No. 1,477,899, FIGURE 6. *Invented by C. W. Rice of Schenectady, New York, and assigned to the General Electric Company.*

This invention introduces what is apparently a novel idea in selective reception of a certain wave, to the exclusion of short-wave interference and strays. The received impulses from the antenna are fed into an artificial transmission line and are taken off this line at four separate points along it. Since the very short-time impulses of static and the like require an appreciable time to travel along the artificial line, they do not reach the four successive pick-up circuits in phase. They do not, therefore, reinforce each other in these circuits, while the impulses due to the wanted signal do reinforce each other.

Using a Dynamo as an Amplifier

No. 1,479,146. *Invented by Ralph E. Marbury of Edgewood Park, Pennsylvania, and assigned to the Westinghouse Electric and Manufacturing Company.*

To the list, already long, of possible principles for the amplification of received radio signals, this invention adds another. The received signal, with or without vacuum-tube amplification, is impressed on the winding of an electric dynamo in such fashion that the signal impulses produce alterations in the magnetic field of the dynamo. These alterations cause corresponding, but amplified, alterations in the output of the dynamo, the additional energy necessary for the amplification being supplied by the energy of rotation of the rotor of the machine. These dynamo-electric amplifiers can be arranged in successive steps, much as with vacuum-tube amplification.



A NEW DEVICE FOR SELECTIVE RECEPTION

FIGURE 6: *The signal is fed into the artificial transmission line at the top of the drawing, this line having an effective length equal to at least several times the wanted wavelength. The shunt resistance, 11, equals the surge impedance of the line and is used to prevent reflection of the wave.*

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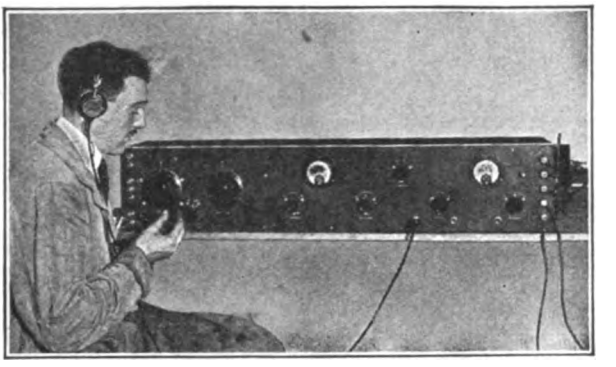
For expensive, delicate parts—what panel will you use?



THE picture shows the front of a Super Heterodyne hook-up. This set has a normal range of 3,000 miles. When a radio fan builds this set he must use the best radio parts he can buy. And he needs a panel that will help those parts operate most efficiently.

A weak battery, a burned-out tube—any defective part merely reduces the range of a set instantly. A cheap radio panel can hinder the effectiveness of the best instruments made.

Radio fans all over the country construct their sets around Celoron Standard Radio Panels. One of them, Mr. Phil Davies, of Grand Rapids, Mich., writes about his Celoron panel:

"I bought a Celoron Radio Panel, first, because of the low loss of high frequency currents and its high dielectric capacity; second, because of its strength and durability; third, because of its beautiful finish; fourth, because of its convenient size."

Radio set manufacturers who use Celoron panels in their cabinets help fans get greater volume and clearer reception. Manufacturers of radio parts who mount their instruments on Celoron bases give insulation those parts need. In Celoron they have a bakelite product that is one of the best insulating materials known. Its dielectric strength has been proved time and again. The U. S. Signal Corps and U. S. Navy approve it heartily.

Radio manufacturers can buy Celoron in sheets, tubes, rods and special forms. Leading radio part makers have already found that Celoron is an ideal material to use for cabinets, switch bases, and other radio and wireless equipment.

Radio fans who buy completed sets containing Celoron Standard Radio Panels and instruments insulated with Celoron can be sure of getting the insulation their sets need. Write us for complete information regarding the use of Celoron in the manufacture of sets and individual radio parts.

Celoron Radio Panels come in the following standard sizes finished in black, mahogany or oak:

1—6 x 7 x 1/8
2—7 x 9 x 1/8
3—7 x 12 x 1/8
4—7 x 14 x 3/16
5—7 x 18 x 3/16
6—7 x 21 x 3/16
7—7 x 24 x 3/16
8—12 x 18 x 3/16
9—7 x 26 x 3/16

Special sizes cut to order from sheet stock. Write for our free booklet, "Getting the Right Hook-up with Celoron." It contains diagrams, list of broadcasting stations, and information every set-builder should have.

To radio dealers: Send for special dealer price list showing standard assortments.

DIAMOND STATE FIBRE COMPANY

Bridgeport, Pennsylvania (near Philadelphia)

Branches in Principal Cities—Toronto, Canada London, England

CELORON

STANDARD RADIO PANEL

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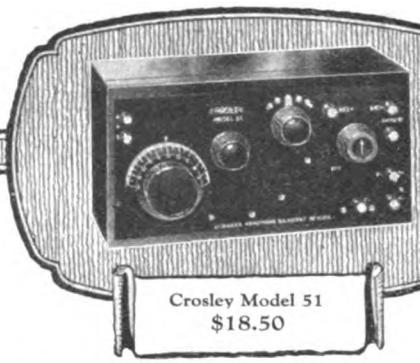


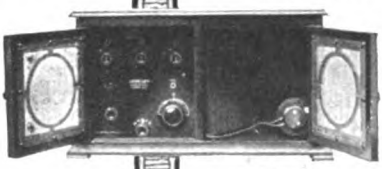
Crosley Model 51
$18.50

A CROSLEY FOR EVERYONE

Priced Exceptionally Low

IT is our ambition that everyone in the United States be enabled to enjoy the innumerable pleasures and benefits that radio provides. We have, therefore, produced in the Crosley line such an extensive assortment of Radio Receivers at prices so reasonable as to bring them within reach of all.

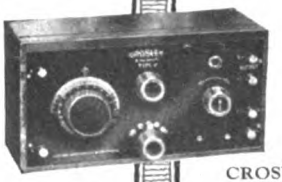
Our newest receiver, the Crosley Model 51, a two-tube Armstrong Regenerative set illustrated above, is indeed a triumph in radio engineering. Although it consists of detector and one stage of audio frequency amplification, it sells at the very low price of $18.50.



CROSLEY TYPE 3-C

CROSLEY TYPE 3-C—$110.00

A beautiful Consolette Model of Mahogany, adding greatly to the interior decoration of any home. It is an Armstrong Regenerative set containing the same units as the Crosley Type 3-B with the addition of a built-in loud speaker. Licensed under Armstrong U. S. Patent No. 1,113,149. Space is provided in the cabinet for housing the necessary batteries. A special mahogany stand for the Type 3-C may be had for $25 extra.



CROSLEY TYPE V

CROSLEY TYPE V—$16.00

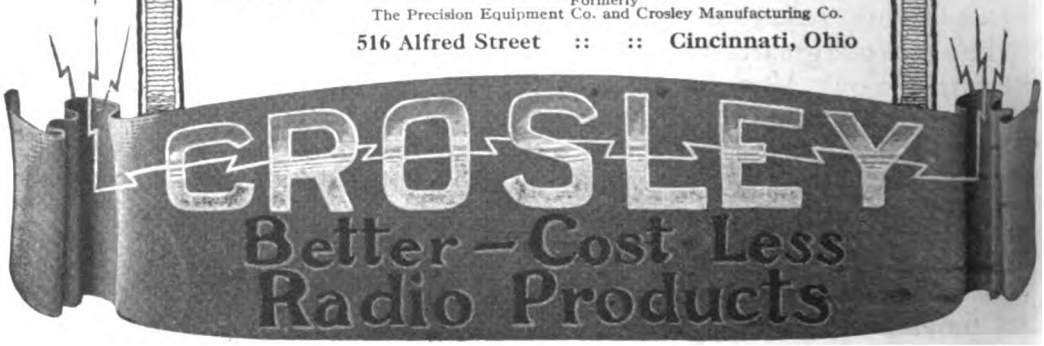
A one tube regenerative set, licensed under the Armstrong U. S. Patent No. 1,113,149. Actual performances of this little receiver have proven a revelation to the radio world. The MacMillan expedition has consistently been clearly brought in with this instrument as well as Honolulu and other far distant points.

Crosley instruments are sold by best dealers everywhere. Write for complete catalog of Crosley receivers and parts

The Crosley Radio Corporation

POWEL CROSLEY, JR., President
Formerly
The Precision Equipment Co. and Crosley Manufacturing Co.

516 Alfred Street :: :: Cincinnati, Ohio



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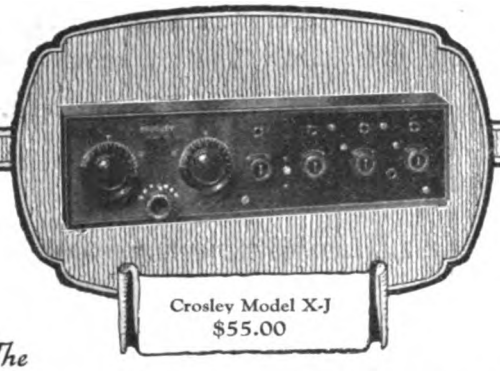


Crosley Model X-J
$55.00

The

FAMOUS CROSLEY MODEL X-J

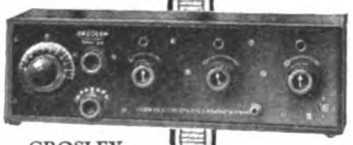
A Long Distance Receiver

PROBABLY the greatest single feature of this Crosley Model X-J receiver is its remarkable selectivity. It will tune through powerful local broadcasting stations and bring in distant stations clearly and with great volume. It is the most popular receiver in America to-day, we believe.

A four tube radio frequency set combining one stage of Tuned Radio Frequency Amplification, a Detector and two stages of Audio Frequency Amplification. A jack to plug in on three tubes for head phones, the four tubes being otherwise connected for loud speaker.

CROSLEY TYPE 3-B—$42.00

This three tube regenerative receiver licensed under Armstrong U. S. Patent No. 1,113,149 combines the Crosley Type V single tube receiver, and the Crosley two stage amplifier. In the hands of amateurs and professionals alike it has consistently out-performed sets costing a great deal more. A person hearing a broadcasting station may turn off the set by throwing switch and come back later without re-tuning.



CROSLEY
TYPE 3-B

CROSLEY MODEL VI—$24.00

A two tube medium range receiver of exceptional merit. Consists of one stage of tuned radio frequency amplification and detector. The one stage of tuned radio frequency amplification not only amplifies the signal before it reaches the detector, enabling the detector to work more efficiently, but it also eliminates interference to a wonderful degree.

CROSLEY
MODEL VI

Crosley instruments are sold by best dealers everywhere. Write for complete catalog of Crosley receivers and parts

The Crosley Radio Corporation

POWEL CROSLEY, JR., President
Formerly
The Precision Equipment Co. and Crosley Manufacturing Co.

516 Alfred Street :: :: Cincinnati, Ohio

CROSLEY

Better—Cost Less Radio Products

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Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

Complete Parts for the Haynes Set

$15.00

Haynes .00023 Condenser
Haynes Bank Wound Coupler
Fada Rheostat
Haynes-Griffin Socket
Switch Arm
4 Switch Points
2 Switch Stops
8 Binding Posts
2 3-inch Dials
Grid Condenser .00025 with leak mtg.
Grid Leak (1 meg)
Bus bar, solder, copper lugs, and all miscellaneous material
7 x 15 Hard Rubber Panel

Send 2c stamp for detailed price list of parts and accessories

PARTS FOR THE Famous Haynes Set

Manufactured by Clapp-Eastham Co.
Licensed under Armstrong Patent 1,113,149

1000 Miles for $15.00

The identical parts used by A. J. Haynes in his own personal receiving set—assuring the utmost in Selectivity, Long Distance Range, Economy, and Simplicity of Arrangement.

The appeal of the Haynes Set is universal. To the experienced amateur because of its astonishing long distance reception and wonderful selectivity; to the radio novice because of its ease of construction and operation. So simple that no one can possibly go wrong.

Send 4c in stamps for interesting article on the Haynes Set described on the opposite page of this advertisement

$12.50

J. Andrew White Loud Speaker!

Major White, "America's Favorite Broadcaster" and former Editor of "The Wireless Age," has embodied in this Loud Speaker the results of his thirteen years of radio experience.

Special non-metallic composition horn and all-wood base assure clear-toned reproduction, entirely free from distortion or metallic sound.

The J. Andrew White Loud Speaker stands 21 inches high with bell 9½ inches in diameter.

Parcel Post Prepaid to all points in the U. S. East of the Mississippi River.

HAYNES-GRIFFIN RADIO SERVICE, INC.

Mail Order Dept.—145 W. 45th Street, N. Y. City
Retail Store—41 W. 43rd Street, N. Y. City

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Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

A. J. HAYNES
Designer of the Haynes Set

Four Notable Articles on RADIO DESIGN

1: "How to Build the Haynes DX Receiver," by Laurence M. Cockaday, Technical Editor of "Popular Radio." (September, 1923 issue.) Mr. Cockaday finds the Haynes Set ideal for the average man who wants ease of operation, great selectivity, and excellent long distance reception.

2: "How to Build a Two-Stage Audio Frequency Amplifier," also by Mr. Cockaday (October, 1923 issue.) This article tells how to build the Haynes Amplifier to give loud speaker volume with the Haynes Set.

3: "A Simplified Super-Heterodyne," by A. J. Haynes (January, 1924 "Radio Broadcast"). The set described represents the result of Mr. Haynes's search for perfection after nineteen previous experimental models had been built.

4: "Shooting Trouble in the Super," also by Mr. Haynes (March, 1924 "Radio Broadcast.") Here Mr. Haynes gives many practical suggestions for meeting almost every conceivable difficulty which may develop in the super-heterodyne.

THE DEMAND FOR THESE ARTICLES IS WORLD-WIDE

In the history of radio no articles on radio design have attracted more widespread enthusiasm. Thousands of letters from all parts of the world have asked us for copies.

Through the courtesy of "Popular Radio" and "Radio Broadcast" we are able to offer them to interested experimenters at the actual cost of printing and mailing.

Simply send 4c in stamps for each article wanted. Use the handy coupon.

New York's Largest Radio Store

Haynes-Griffin
145 W. 45th St.,
New York City

Send me articles checked below. I enclose 4c in stamps for each one wanted:

1: Haynes DX Receiver
2: Audio Amplifier
3: Simplified Super
4: Shooting Trouble

.....

.....

The Haynes Condenser

$3.50

Meets every requirement — extreme low minimum capacity and maximum capacity of exactly .00023 mfds. No other condenser is exactly like it—no other achieves just the right balance between perfect selectivity and over-critical adjustment.

The Haynes Bank Wound Vario-Coupler

$4.35

Furnished with only the taps you actually use and just the right number of turns on the secondary. Bank winding provides 100% efficiency on higher broadcasting wave lengths.

Haynes-Griffin Transformer

$4.25

An efficient intermediate wave radio frequency transformer; uniformly tuned to a limited wave length range, and providing a degree of quietness heretofore unknown in transformers of this type. Haynes-Griffin Input Transformer also $4.25.

HAYNES-GRIFFIN RADIO SERVICE, Inc.
Mail Order Dept.—145 W. 45th ST., N. Y. City
Retail Store—41 W. 43rd ST., N. Y. City

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clearer Tone!

N&K
"KING OF THE AIR"
TRADE MARK
PHONES

N & K Phones are designed for just one purpose — the *natural reproduction* of musical tones. They are sold under a guarantee to reproduce both high and low tones more clearly, with greater naturalness and mellowness. They will not increase the loudness of weak signals — because *all* the tones, high and low, have to be kept in *natural proportion*, to secure such mellowness as N & K gives. It's the job of your radio *set* to give volume.

Fans and mere beginners alike are enthusiastic over N & K's wonderful clearness. Out of several hundred amateur stations that tested N & K Phones last year, a full 90 per cent pronounced them the best they had ever used.

"Entirely free from mechanical sounds" says Station 1PX. "Exclude noise of visitors moving around operating room" says Station G.R.R. "Tone soft and clear as a bell" says 1FI; and so on. We will gladly send you our new folder reproducing other comments from fans and telling the real reasons *why* N & K Phones reproduce more clearly than other phones. *Write now.*

N&K Head Set, Model D, 4000 ohms, is a remarkable example of skillful workmanship. Made of nickeled brass, with hard rubber ear caps, accurately machine threaded to insure proper seating of diaphragm. A special device insures uniform spacing between diaphragm and magnet poles. Magnets of finest German steel, wound by entirely new method. Sanitary headband, covered with genuine leather. Six foot cord. Price, $8.50.

TH. GOLDSCHMIDT CORP.
Department P5
15 William Street
New York, N.Y.

DEALERS: — N & K Phones are being backed by a wide advertising campaign that is already bringing a big increase in sales. Until the announcement of our complete distributor organization, we will see that you are promptly supplied with N & K Phones if you order direct from us. N & K comes packed in cartons of ten with advertising display cards for window and counter and leaflets. Write or wire for carton today.

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NEW YORK AMERICAN
March 14, 1924.
Phenix Radio Corp.,
5 Beekman St., N. Y.
Gentlemen:
In answer to your inquiry as to what type set I used in receiving the British Broadcasts on the evening of Thursday, March 13th, I am glad to inform you that it was your eight tube Ultradyne which was submitted by you to our Certified Radio Department for test.
The reception was made at my home which is located in an apartment house in the Bronx.
Very truly yours,
WM. G. H. FINCH
Radio Editor
March 15, 1924.
Mr. W. G. H. Finch,
New York American
238 William St., N. Y.
Dear Mr. Finch:
Accept my warmest congratulations on your fine achievement in being the first person not only in New York, but in all America, to report reception of the first concert ever broadcast from Europe to all America on Thursday, March 13th, from the Savoy Hotel, London, England.
Cordially yours,
RICHARD TEMPLE
In charge of arrangements.
LOOP
TUNER
OSCILLATOR
2 STAGE
1 STAGE
DET.

"The Standard of Comparison"

Send for the 32-page illustrated book giving latest authentic information on drilling, wiring, assembling and tuning 6 and 8 tube Ultradyne receivers.

50c

ULTRADYNE
The Improved SUPER-HETERODYNE

Employs "Modulation System," an entirely new principle of radio reception just developed and perfected by R. E. Lacault, A. M. I. R E., technical editor of Radio News and formerly Radio Research Engineer with the French Signal Corps Research Laboratories.

This principle is of such a basic character that the sensitiveness is increased over that of any known receiver. Weakest signals are made to operate the loud speaker. Results secured by the Ultradyne exceed by far those obtained with Reflex, Super-Regenerative, Neutrodyne and even with the well-known Super-Heterodyne. This is true in regard to selectivity, range, signal audibility, simplicity and general efficiency.

The "Modulation System" is employed exclusively in the Ultradyne, the improved and simplified Super-Heterodyne.

Write for descriptive circular

PHENIX RADIO CORP.

7-9 Beekman Street :: New York City

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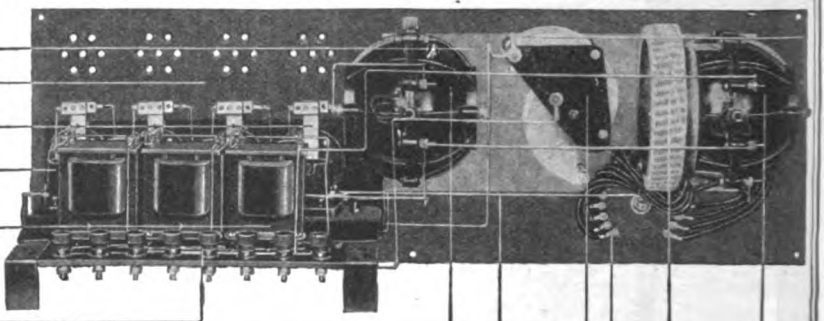
A NEW CIRCUIT DIAGRAM—READ IT!



It's Not the Face of the Watch, It's the Works that Tell the Story.

1. **Variable Condenser.** Contains forty-three plates of heavy aluminum with five plate vernier for fine tuning. Mounting plates of heavy Bakelite. Ends of rotor plates bolted, preventing bending or "shorting." Large bearings make smooth easy operating.

2. **Inductance Coil.** Increases the wave range of the variocoupler to 3000 meters. Diamond wound for minimum distributed capacity. Tapped for selective tuning.

3. **Variocoupler.** Coupler shell and rotor built of solid Kellogg Bakelite, treated to avoid "distributed capacity." Many radio experts consider this the best coupler obtainable today.

4. **Variometer.** Rotor shaft accurately and permently held in bearings. No sliding contacts. This variometer gives great added selectivity, more value.

5. **Transformers.** Designed to overcome defects of existing types and to furnish distortionless amplification of all audio frequencies. Sheet metal case heavily enameled. Primary and secondary binding posts most accessibly placed on the transformer, plainly marked.

6. **Rheostats.** Have strong, wide springs, grasping the rotor resistance on two sides with strong, positive contact. The control varies on the half turn of the coil wire on the rotor, giving vernier effect and enabling the operator to secure great selectivity, and freedom from noise and trouble.

7. **Tube Sockets.** All Bakelite. Bayonet slot reinforced with brass plate. Terminals plainly marked. Heavy springs inset into base, so they cannot touch mounting surface. With Kellogg tube sockets there is no worrying about proper connection with your lamp terminals.

8. **Binding Post Assembly.** Symphony Binding Posts connect through separate openings in the rear of the set. Each of these openings have an insulating bushing. This does away with unsightly and unnecessary wiring connections on the front panel.

9. **Bakelite Panel.** This slender, strong, highly polished panel has the equipment located upon its face in the most advantageous positions. These mountings fit most accurately drilled openings and this face equipment is a model of proper radio assembly.

10. **Aluminum Shielding.** One who has not operated a radio set cannot appreciate the importance of careful shielding and grounding. Symphony shielding is pure aluminum and ample size, correctly drilled.

11. **Circuit.** The circuit of the Symphony is controlled by the apparatus above described, and mechanically wired as indicated, produces receiving of the highest order.

12. **Contact Points.** Heavy, silver plated for minimum resistance, an instance of the fine and all important attention to details that makes for successful radio receiving.

In addition to the important, accurate and successful units pictured above, there are also the other Kellogg radio parts to complete this most efficient circuit

Mr. Dealer:
Write for our bulletins and discount sheet. The Symphony will increase your profits.

Jones RADIO Company
1066 W. Adams Street, Chicago, Ill.

The Symphony is manufactured under the U. S. Patent No. 1113149, Armstrong Regenerative Circuit

All parts used in the Symphony are built and guaranteed by the Kellogg Switchboard & Supply Company, manufacturers for twenty-five years of complete telephone equipment

Mr. Radio Fan:
If your dealer does not carry Symphony receivers, send us his address. We will send you our illustrated Symphony catalog by return mail.

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Pioneers in the development of sound reproducing and amplifying equipment

THE new model R3 is distinguished by two important features—a Volume Control, and reduction of current consumption to a point where it need no longer be taken into consideration.

THIS instrument sets a new and higher standard of adaptability, refinement and also economy of operation. By means of the new Volume Control, reproduction can be adjusted at any degree from very loud to very soft.

R3—(As illustrated) with Volume Control $35.00
R2—(*New Model*) with Volume Control . 50.00
M1—Requiring no battery for its operation 35.00

Magnavox Reproducers, Power Amplifiers and Combination Sets may be had of good Dealers everywhere. Write for catalog.

THE MAGNAVOX CO., OAKLAND, CALIF.
New York Office: 370 SEVENTH AVENUE
Canadian Distributors: Perkins Electric Limited, Toronto, Montreal, Winnipeg

MAGNAVOX PRODUCTS
There is a Magnavox for every receiving set

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"The Best That Money Can Buy"

"GOLD SEAL" HEADSETS

"GOLD SEAL" HEAD SETS are electrically and mechanically,—as well as from a radio standpoint,—as perfect as the highest-priced Head Set on the market,—yet, with all their perfection, they retail at only $6.00 for 2200 Ohm and $8.00 for 3200 Ohm.

The trade mark "DEVEAU" has stood for the highest quality in telephone apparatus for thirty years,—a guarantee that every known advantage in design and manufacturing has been taken into careful consideration.

Magnets are extra-heavy one-piece units; cups are of aluminum to keep down the weight but unlike other Head Sets, every exposed metal part of the set is finished in genuine 24-karat gold,—under a protective lacquer so that the finish will last for years; the terminals of each unit are concealed,—no contact possible with users' hands.

"DEVEAU GOLD SEAL" HEAD SETS are like a piece of fine jewelry in appearance, but with all the radio niceties that the most advanced radio enthusiast can desire. DEVEAU Units exactly match each other in tone,—each has maximum sensitivity and perfection of tone quality.

"DEVEAU GOLD SEAL" HEAD SETS are guaranteed to be electrically and mechanically perfect,—our Guarantee protects every purchaser.

STANLEY & PATTERSON 27 WARREN STREET 23 MURRAY STREET

NEW YORK CITY, U. S. A.

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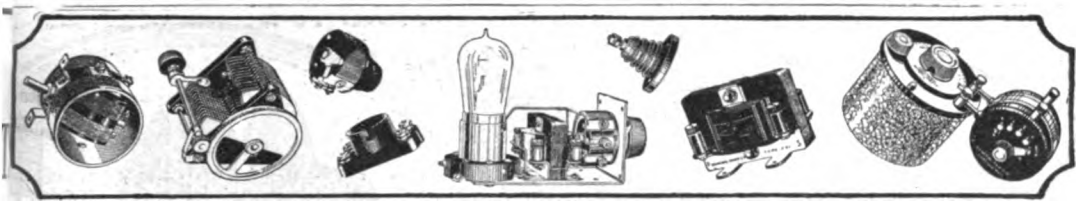
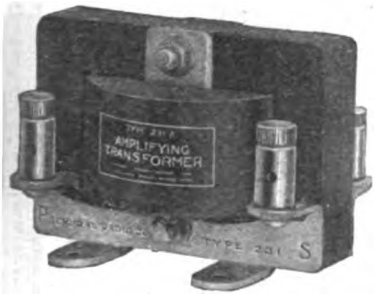
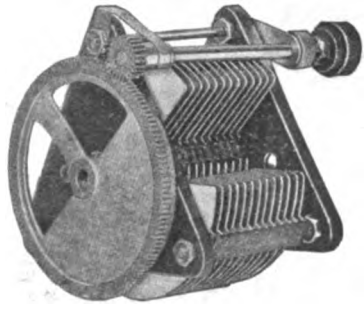


Standards of Excellence



GENERAL RADIO COMPANY

"Products of Proven Merit"



TYPE 231-A AUDIO TRANSFORMER

The first closed core transformers on the market available for use in broadcast receivers were built by the GENERAL RADIO COMPANY, nearly a decade ago.

Today the type 231-A is the standard of excellence in transformer construction.

Thousands of these transformers are in use by fans throughout the entire radio world. They have proven a source of delight to "listeners-in" everywhere because of their volume and quality of amplification.

Many of the leading manufactured broadcast receivers are using GENERAL RADIO CO. transformers as standard equipment — because of their unfailing satisfaction.

Whether you are building a set or buying one, the question of "Quality Amplification" will be settled once and for all if you insist upon the GENERAL RADIO CO. transformers.

Winding Ratio 3.7 to 1. Impedance Ratio 10 to 1.

PRICE $5.00

TYPE 247-H VARIABLE CONDENSER

The 247-H geared variable condenser is the product of extensive laboratory research by skilled radio engineers.

In its design are incorporated features which promote the utmost electrical and mechanical efficiency.

Its method of vernier adjustment is particularly commendable.

By using the counter-balanced gear, operated by a pinion, capacity may be accurately controlled to a minute degree—thus making possible extreme selectivity.

Its bearings are smooth running and its dielectric losses are low.

Due to its critical capacity control and general over-all efficiency, the 247-H condenser is readily adaptable to use in a wavemeter and filter as well as in the receiver circuit.

Capacity of the 247-H condenser .0005 microfarad.

PRICE $5.00

Write TODAY for our Instructive Folders on "Quality Amplification" and "Quality Condensers" and our new Radio Bulletin 917-U

GENERAL RADIO Co

Manufacturers of
RADIO AND ELECTRICAL LABORATORY APPARATUS
Massachusetts Ave. and Windsor St.

CAMBRIDGE .·. .·. **MASSACHUSETTS**

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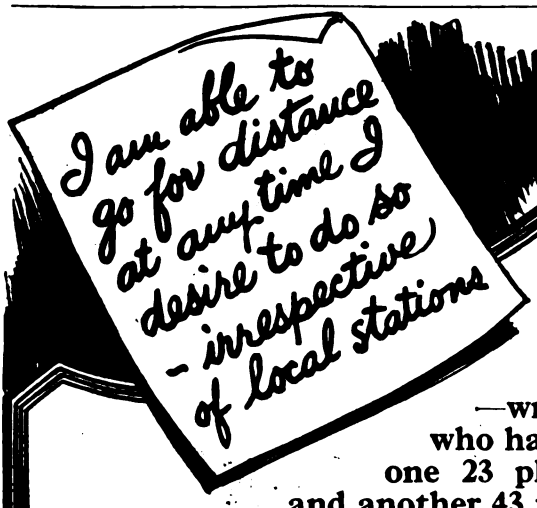


—writes a man who has just changed one 23 plate condenser and another 43 plate condenser to

"FRESHMAN SELECTIVE" VARIABLE CONDENSERS

THIS is only one of the many unsolicited letters we are receiving from people who have changed from the ordinary plate type condenser to the Freshman Selective. You are missing fully 50% of the real thrill and enjoyment of radio if you have not equipped your set with Freshman Selective Variable Condensers. Engineering tests have proved their high efficiency, low phase angle loss, high insulation, freedom from leakage. These tests have been substantiated in actual practice in Neutrodyne, Super-Heterodyne, Reflex and other popular circuits.

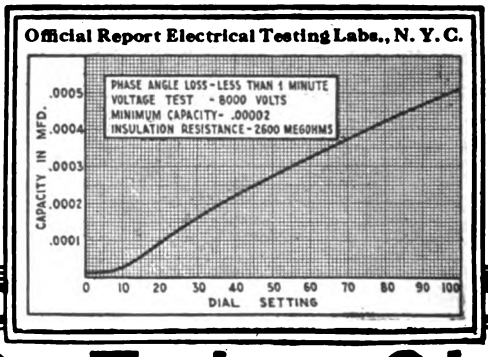
For Transmission or Reception

Attractively compact.

Quiet in operation.

Withstands 8,000 Volts. Cannot short circuit.

The only variable condenser the plates of which actually vary in area.



Prices:

.0003 MF..... (Equiv. to 17 pl.) .0005 MF..... (Equiv. to 23 pl.) .001 MF..... (Equiv. to 43 pl.) $5 EA.

With 3 inch Vernier Dial $5

With 4 inch Vernier Dial 50c. extra.

Ask your dealer or write for our free diagram of Neutrodyne, Super-Heterodyne, Tri-Flex and other good circuits.

Chas. Freshman Co. Inc.
Radio Condenser Products
106 Seventh Avenue, New York City

At your dealer's otherwise send purchase price and you will be supplied without further charge.

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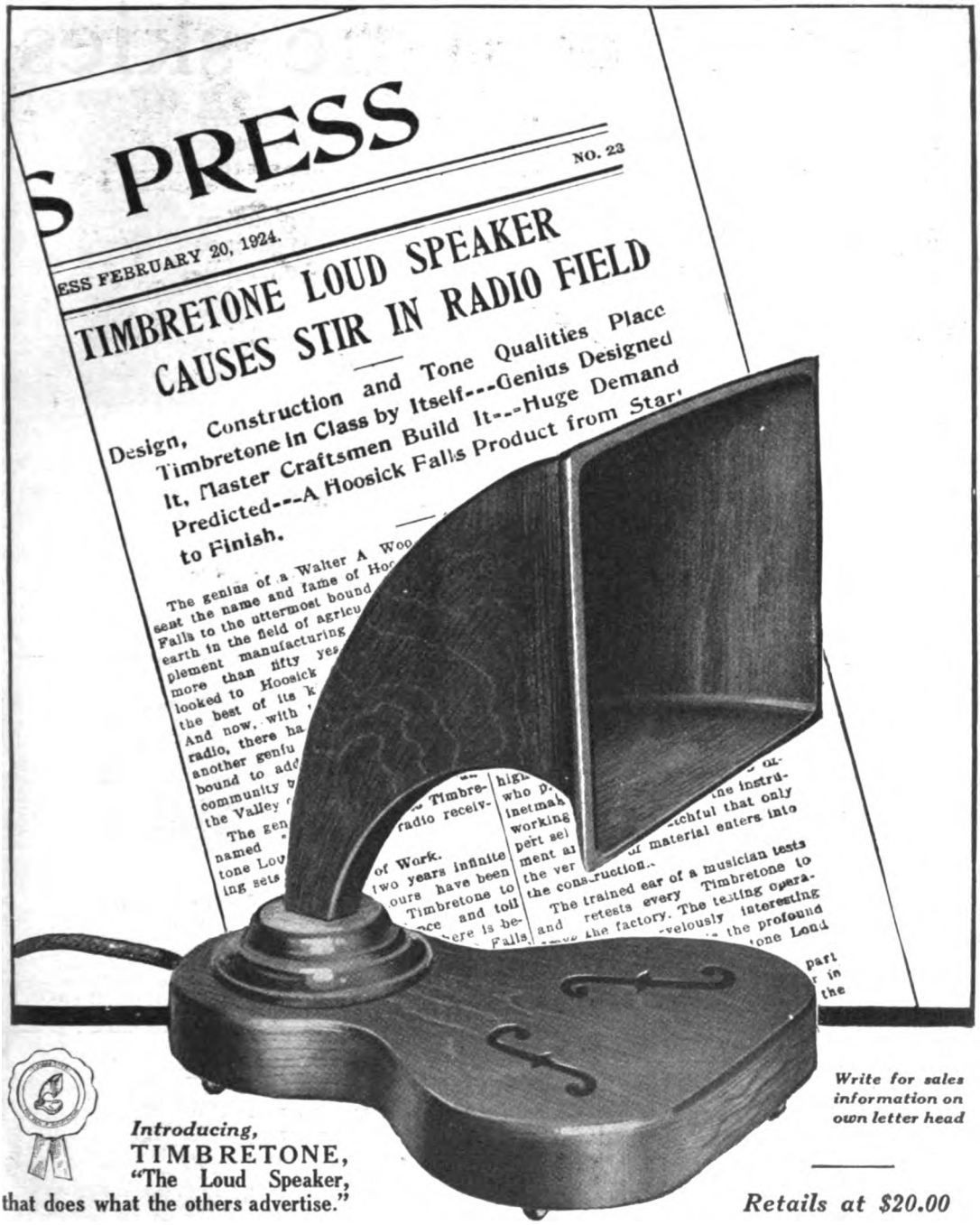
S PRESS
NO. 23
ESS FEBRUARY 20, 1924.
TIMBRETONE LOUD SPEAKER
CAUSES STIR IN RADIO FIELD
Design, Construction and Tone Qualities Place
Timbretone In Class by Itself---Genius Designed
It, Master Craftsmen Build It---Huge Demand
Predicted---A Hoosick Falls Product from Star
to Finish.

Introducing,
TIMBRETONE,
"The Loud Speaker,
that does what the others advertise."

Write for sales information on own letter head

Retails at $20.00

An innovation that makes it the finest toned reproducer of Radio Broadcasting on the market today. Made entirely of wood, eliminating all metallic sound—like the violin, it improves with age. Sold with "Satisfaction guaranteed or your money returned." Finished in Mahogany, Oak or Natural Maple.

Made in Hoosick Falls, N. Y., by the TIMBRETONE MFG. CO.

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Clear from the skies

You can get greater clarity with a good storage battery than by any other means. If you are in any doubt about this important matter, try some friend's set that is hooked up to an Exide Battery.

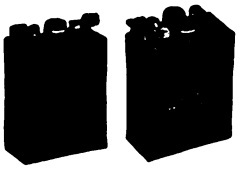
It is a fascination to see how far distant a station you can tune in, but still more fascinating to get it so clearly that you actually enjoy the concert.

Two things to remember

There are two things to remember about Exide Batteries: They give uniform current over a long period of discharge. This means not only clear reception but economy.

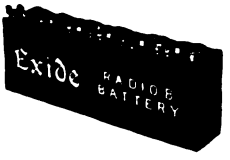
The second thing to remember is that there is an Exide Radio Battery made for every type of tube. In addition to the "B" battery there are Exide "A's" for 2-volt, 4-volt and 6-volt tubes.

From the "midget" five-pound battery for low-voltage tubes to the larger battery for six volts, each Exide is powerful, rugged, silent, and so long-lasting that it makes for true economy.



For low-voltage tubes

Specially designed for WD-11 and UV-199 vacuum tubes, but can be used with any low-voltage tube. The two-volt Exide A Battery consists of a single cell. It will heat the filament of a WD-11 or other quarter-ampere tube for approximately 96 hours. The 4-volt A battery, having two cells, will light the filament of a UV-199 tube for 200 hours.



Exide "B" Battery

Exide
RADIO BATTERIES

For six-volt tubes

Made in four sizes—of 25, 50, 100, and 150 ampere hour capacities. Like all Exides this battery is conservatively rated. It has extra-heavy plates assuring constant potential over a long period of discharge.

And the reason is obvious

The Exide Radio Battery results from experience in the radio field dating far back of amateur radio. In fact, a majority of all government and commercial radio plants are equipped with Exide Batteries. The giant dirigible Shenandoah and the great ship Leviathan are Exide-equipped.

Go to any radio dealer or Exide Service Station and ask for Exide A and B Batteries. If your dealer cannot supply you with free booklets describing the complete Exide line of radio batteries, write to us.

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

In Canada, Exide Batteries of Canada, Limited, 133-157 Dufferin Street, Toronto

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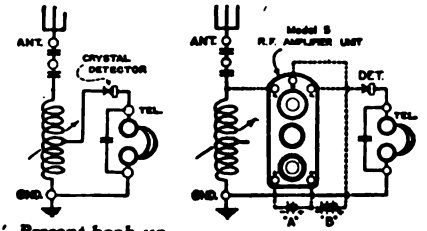
How to get increased distance with your crystal set

with BALLANTINE VARIOTRANSFORMER *UNITS*



Present hook-up tunes broadly

Revised hook-up

YOUR crystal set is the starting point on which to build a good distance receiver. For authorities agree that there is nothing finer than a good crystal for clean-cut detection—not so loud as a tube, perhaps, but much clearer. Simplicity itself is the crystal. And its improved modern forms and mountings make adjustment easy. By all means, keep this element with which you are already familiar.

Use tubes to best advantage

Tubes, of course, are needed for amplification—to build up weak distant signals so that they may operate your crystal detector. But, by putting your money for tube equipment into one or more stages of radio frequency amplification, tuned with BALLANTINE VARIOTRANSFORMER Units, you will get increased distance. And with this method there comes a greater selectivity, accompanied by a reduction of interfering noises. In fact, BALLANTINE amplification into a crystal detector may be made as clear as a victrola. Furthermore, the full possibilities of your tubes may be developed without annoying your neighbors.

Complete radio frequency amplifier unit with socket and rheostat $15.00

Transformer only for panel or base $9.60

At dealers or postpaid

Easy changes quickly made

The above diagrams show how one popular make of crystal set can be brought up to date quite readily—only a slight rearrangement of wiring to hook in the first BALLANTINE Unit. And it's just as easy with any other crystal hook-up. Additional BALLANTINE Units may be inserted from time to time.

Try this instrument. Then, if there's anything you don't understand, our staff engineers will help you out.

Booklet tells how to improve crystal sets

"Radio Frequency Amplification with the BALLANTINE VARIOTRANSFORMER," is the title of our 25-page booklet, packed with useful data, charts and diagrams. Send for your copy now.

BOONTON RUBBER MFG. CO.
Pioneers in Bakelite Moulding
224 Fanny Road, Boonton, N. J.

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ATWATER KENT

Philadelphia

Highly Selective and Easy to Operate

IT is easy to operate an ATWATER KENT Receiving Set—anyone can tune in a distant station and obtain clear reception — its wide range, accuracy, and simplicity have made it an outstanding preference among families the nation over.

The tonal fidelity of an ATWATER KENT Loud Speaker is the delight of every owner.

ATWATER KENT MFG. COMPANY
4933 STENTON AVE., PHILA., PA.

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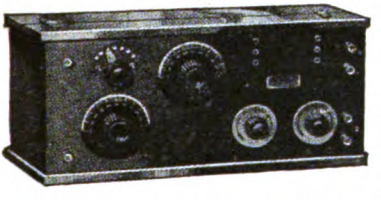
Everyone Can Now Own a Quality Radio Set



This is Model K—the much-talked-of outfit with which Mr. E. D. Elliott of Milford, New York, got London, England, Fairbanks, Alaska—La Palma, Panama, San Francisco—Los Angeles and about 122 other long distance stations.

It's a two-tube outfit that sells for only..... **$29.50**

MODEL MW

Shown in the illustration at the top of the page is our 4-tube outfit that can be used with a loud speaker. It sells for only $54.50.

Write for Bulletin

THESE two Improved Miraco models make it possible for every family to own their own set—to have a choice seat for the opera or symphony or jazz concert right in their own living room.

Improvements and refinements that appear in expensive sets only are built in each and every MIRACO. In other words, *highest quality* at the *lowest price* has been solely responsible for the sale of thousands of our sets that are bringing radio-joy to each and every family who own one. Users of Miraco sets report getting as many as fifty stations in one evening.

The cabinets are of solid mahogany and workmanship is unexcelled. Easy and simple to operate and always dependable. Fully GUARANTEED against any defects in workmanship.

Write for our new bulletin TODAY

Dealers — Jobbers: Write for proposition quickly

Agents: There's still some territory open—write or wire

THE MIDWEST RADIO COMPANY
812 Main Street, Cincinnati, Ohio

The Improved MIRACO

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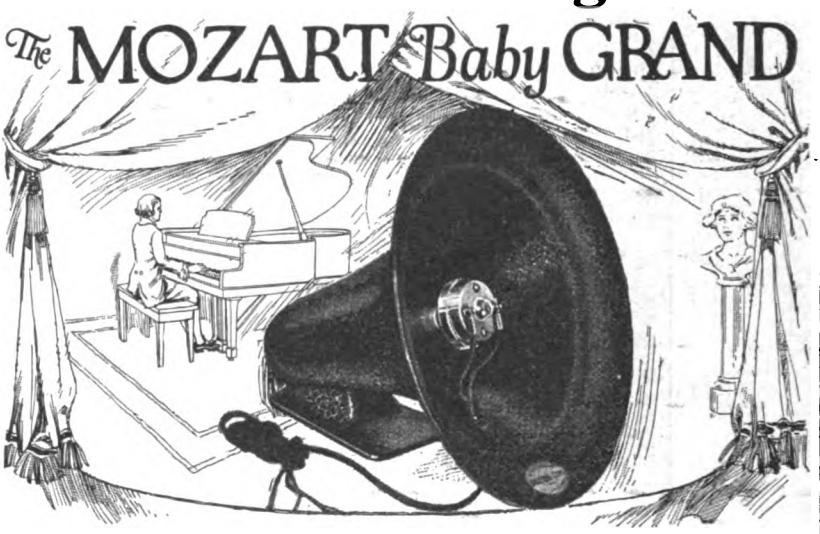
Considering
The MOZART Baby GRAND



OUR new reproducer is now under consideration by thousands of radio enthusiasts throughout the country. Singularly, many of the most expert are making quick decisions and below we quote from an opinion, entirely unsolicited, given us by Mr. C. E. Mattson, Baltimore.

> "I gave the sample a test at one of the radio stores. About 15 customers crowded round and all agreed it was equal to the $35.00 —and won by several lengths against the $30.00—. My own opinion is that the M-G is going to be the greatest hit in radio this and next season——"

Within five days (date of going to press) from receiving above, we have had orders for immediate shipment, aggregating exactly 146 complete reproducers and a large quantity of extra units for other makes of horns and phonographs from Mr. Mattson and his customers.

Prices. An Explanation.

We have been reluctantly obliged to slightly increase our price and to prospective purchasers a full explanation will be mailed on receipt of a postal card.

Complete with (gold plated) unit and cord, ready for attaching.. **$12.00**
West of the Rockies..... **$12.65**
Unit only (gold plated) with cord ready for attaching..... **5.00**
Unit only (nickel plated) with cord ready for attaching..... **4.00**

The MOZART-GRAND CO.

Manufacturers of Fine Instruments

NEWARK, N. J. **U. S. A.**

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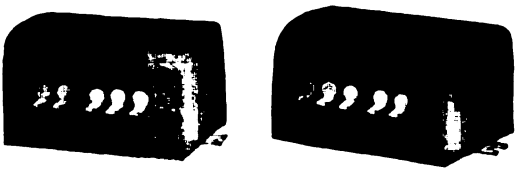
"Take No Chances—Use Como"

The World's Standard Push-Pull Transformer



"COMO DUPLEX" TRANSFORMERS

(Push-Pull Power Type)

THE first and best power type transformers offered the radio enthusiast. In competition COMO stands alone! We can prove it. Mr. Laurence M. Cockaday, well known Radio Engineer, specifies COMO push-pull transformers in his latest radio receiver—the four circuit tuner—Take advantage of Mr. Cockaday's experience and use COMO yourself to obtain greater Volume, better quality and freedom from tube noises that ordinary transformers produce. A great deal of the noise that is blamed on "static" is really tube noise amplified by improperly designed transformers. COMO may be used with your present amplifier, giving you more volume on weak signals that more of the ordinary amplification would kill.

Send for Copy of—

"How to build a Power Amplifier"

Over 10,000 replies were received from **one** *article pertaining to power amplification using "Como Duplex" transformers—most of those who replied are now enthusiastic users. Why not join them?*

PRICE $12.50
Per Pair

COMO APPARATUS COMPANY

446 Tremont Street **Boston, Mass.**

THEY ARE FOR SALE AT LEADING DEALERS

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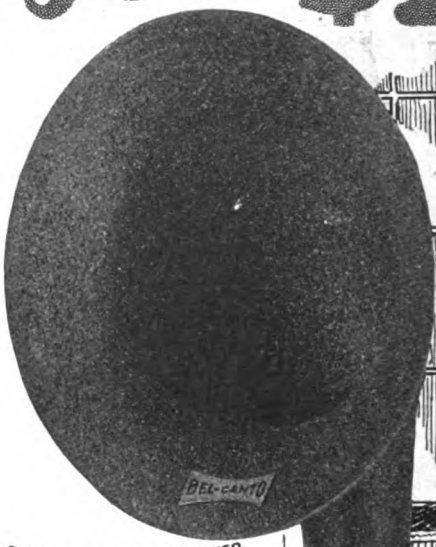
$25 for $10

The Famous BEL-CANTO Acoustical Amplifier

Direct from Manufacturer to you



THE ACOUSTICAL AMPLIFIER
BEL-CANTO
TRADE MARK

You cannot buy the BEL-CANTO from any dealer

Only direct from us. We save you these three profits
DISTRIBUTOR, JOBBER and DEALER

Call at our factory, send us your check, money order, or pay the postman $10.00. Prepaid to any part of U. S. and possessions.

Tel. Vanderbilt 8959

C. O. D. Delivered to your door

GUARANTEE

Money back any time within ten days if dissatisfied. We further guarantee to the publication carrying this advertisement that each and every speaker sold will be exactly as advertised in this issue.

7 POINTS OF BEL-CANTO SUPERIORITY

1. Our own fiber horn. Crystalline finish.
2. Our own adjustable loud speaking unit, giving a wide range of tone quality and volume without distortion.
3. The base of cast iron, weighing four pounds, eliminating top heaviness.
4. All other metal parts are of heavy cast aluminum, highly polished.
5. Complete instrument stands 24 inches high, 10 inch bell.
6. Guaranteed for one year from date of purchase against mechanical defects of any kind.
7. No auxiliary batteries required. Just plug in on 2nd stage.

Price $10

BEL-CANTO MFG. CO.

BENSEL-BONIS CO., Inc.
General Office and Factory, Dept. P. R. 417-419-421 East 34th St., N.Y.C.

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Eagle Neutrodyne Balanced! RADIO RECEIVER

THE sheer weight of overwhelming merit, has given to the name "Eagle", in a short time a tremendous significance — the greatest of neutrodyne receivers. Hearsay, mere "claims" or boasting could not have produced such sensational prominence. This is the verdict of radio engineers, leading authorities and of radio fans who have made an absolutely unbiased comparison.

The secret of the EAGLE'S marked superiority is its infinitely fine balance —as perfect, as flexible, as dependable as that of the carefully trained tight-rope walker to whom balance means life itself. Balanced tube capacities is the fundamental principle of the EAGLE Neutrodyne Receiver.

Each *EAGLE Neutrodyne Receiver* is balanced by a neutrodyne expert with the same unhurried, painstaking precision as devoted to the first EAGLE. As easily operated as a phonograph. Guaranteed without reservation.

Write for literature.

***

Licensed by Independent Radio Manufacturers, Inc., under Hazeltine Patent No. 1,450,080, dated March 27th, 1923, and other patents pending.

Write for Illustrated Leaflet

Perfect Balance Secret of **Eagle** *Supremacy*

WE SOAR ABOVE

EAGLE RADIO COMPANY

NEWARK NEW JERSEY

18 Boyden Place

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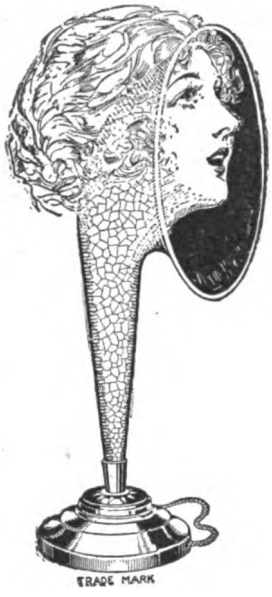
Attend the Presidential Conventions !



Complete **$25**

Atlas Unit with phonograph coupling..... **$13.50**

Through the

Atlas
TRADE MARK
RADIO-REPRODUCTION LOUD SPEAKER

HEAR the famous speakers as distinctly as though you were actually present. The ATLAS produces this marvelous illusion. Give your family and friends a real treat. Order your ATLAS Loud Speaker now.

Booklet "B" Upon Request

Multiple Electric Products Co. Inc.

Makers of Time-Lag—MONO-FUSES—Multiple

2 ORANGE STREET :: NEWARK, N. J.

District Offices in

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DENVER, COLO. SAN FRANCISCO, CAL.

Sole Canadian Distributors, Marconi Wireless Telegraph Co. of Canada Ltd., Montreal, Canada

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This Certificate Opens the Way to the Best Radio Positions

Get It—You Can Earn Big Money With It

No previous experience in Electricity or Radio is necessary. In a few short months, you can easily win this certificate and qualify for one of the splendid, big money positions in Radio.

Merle Wetzel of Chicago Heights, Ill., advanced from lineman to Radio Engineer, increasing his salary 100 per cent. **even while taking our course!** Emmet Welch, right after finishing his training, started earning $300 a month and expenses. Another graduate is now an operator of Broadcasting Station PWX of Havana, Cuba, and earns $250 a month. Still another graduate, only 16 years old, is averaging $70 a week in a radio store. Hundreds of other men are occupying equally attractive positions after winning our Certified Radio-trician certificate.

Easy Now to Become A Certified Radio-trician

No other work in the world today offers such opportunities, such big money, such rapid advancement, such a promising future as does Radio. And the Expert Radio-trician is the man who is in a position to choose the best of these opportunities—to jump farthest ahead in this newest and fastest growing industry.

Become an Expert Radio-trician. You can—easily and quickly. The National Radio Institute, America's first and largest Radio School, has devised a remarkable method that makes it easy for anyone to qualify right at home during spare time. Prominent radio experts give you personal advice and instruction through the mail. They grade your papers, answer your questions, and in every possible way help you in your work. And you learn the practical, wonderful side of radio by actual practice on patented instruments we send you free. The Certified Radio-trician Certificate awarded you on the completion of your course **is government recognized, counting for 5 to 10 points on all government license examinations.**

A Few of Many Letters We Receive Which Explain How We Place Graduates in Radio Position

We are in need of the services of a competent radio engineer who has a thorough knowledge of radio, together with selling ability, and would appreciate it if you could recommend to us any person or persons that could fill a position as outlined above.
DX-INSTRUMENT CO.

Good Future

I want a man who can show the customer about circuits, and answer questions. One who can set up sample sets.
He must hold at least a third grade commercial license in order that our broadcast station may be operated at least twice a week. This position offers a fine future to the right man.
JOHN R. KOCH

Executive Position

We thought you would be in a position to cooperate with us in securing men with executive ability as well as knowledge of the Radio business to take charge of our offices as local managers.
UNIVERSAL RADIO CO.

Instruments Free to Students

An extraordinary feature of this course is the use of four patented instruments, owned exclusively by us, which give practical training in radio operation, installation, maintenance and repair—all of which you **must** have to become an Expert Radio-trician.

Also, now included free with course, are circuits and parts for building the latest receiving sets.

Send for Radio Book

Thousands of positions are open to Certified Radio-tricians. Find out what **your** opportunities are in this fascinating profession. Send for interesting book, "Rich Rewards In Radio," which gives complete details on plan by which the National Radio Institute quickly qualifies you at home in spare time as a Certified Radio-trician. Send the coupon or a postcard for free book NOW. **NATIONAL RADIO INSTITUTE, Dept. 32EA, Washington, D. C.**

Radio Operator

Redio Mechanic

Radio Salesman

Radio Engineer

NATIONAL RADIO INSTITUTE, Dept. 32EA, Washington, D. C.
Send me your book, "Rich Rewards In Radio," with full particulars about the opportunities in radio, and how you will quickly train me in my spare time at home to win a Certified Radio-trician Certificate. Also about your employment service

Name ..... Age .....
Street ..... Occupation .....
City ..... State .....

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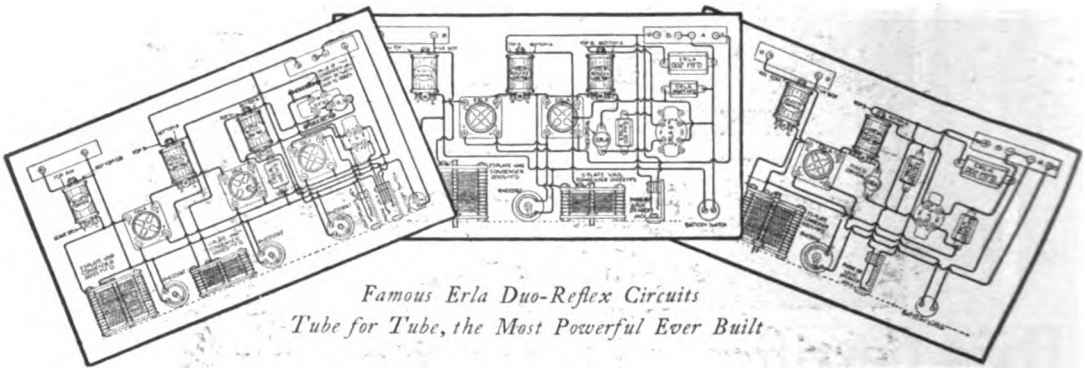
No Circuits Equal These

In Range, Purity, Volume!



Famous Erla Duo-Reflex Circuits
Tube for Tube, the Most Powerful Ever Built

TIME serves only to emphasize the superiority of Erla Duo-Reflex Circuits—tube for tube, the most powerful circuits ever built.

An Erla circuit introduced efficient one-tube loud speaker reception, and still stands unsurpassed. So too, Erla two and three-tube circuits remain unchallenged, outstripping four and five tubes otherwise employed.

Even in minor phases, Erla superiority is pronounced. Control is positively fool proof, eliminating reradiation and distortion, while stability is so complete that every station is heard invariably with the same dial setting.

Underlying the efficiency of these circuits, and the mainspring of their success, are Erla radio and audio transformers. Through synchronizing perfectly received radio, reflexed radio and reflexed audio frequency currents, they enable vacuum tubes to do triple duty, multiplying amplification without flaw.

Equally indispensible to maximum efficiency are Erla Selectoformer, Erla fixed crystal rectifier and Erla condensers, meeting completely the exacting requirements of reflex design.

For complete information, ask your dealer for Erla Bulletin No. 20; or write direct.

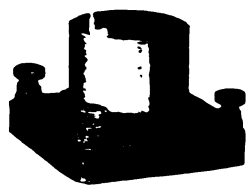
Maximum range, selectivity and volume are positively assured through Erla radio frequency transformers. Reflex and cascade types. $5

Superior quality of Erla audio tranformers stands clearly revealed in their ability to amplify three stages without flaw. $5

Extreme sensitiveness and perfect stability of Erla fixed crystal rectifiers meet every requirement of reflex operation. List, $1

Erla Selectoformer betters coupling between any antenna and any receiver, with resultant increase in range and selectivity. List, $5

Erla condensers alone bear the words "tested capacity" on their labels, guaranteeing superior accuracy at no extra cost. 35c to 75c ea.



Exclusive features of Erla sockets are now available in 199 as well as standard size. Quality and workmanship unequaled. 65c and 75c

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Dept. R. 2500 Cottage Grove Ave., Chicago

ERLA

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If you closed your eyes you'd think
you were in the Fifth Row Center

You can hear the *softer* tones

PLUG in a pair of Murdock Radio 'Phones—and tune-in on New York. You'll think you are in the fifth row center at a Broadway musical show—at the Symphony Concert, or the Opera. Everything is reproduced—the clear notes of the singer's voice, the high and the low tones of the violin, the saxophone of the jazz orchestra.

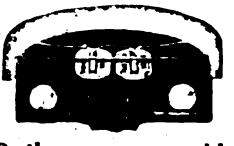
Perfect diaphragm adjustment the secret

THE correct seating and clamping of the diaphragms are important factors in the success of Murdock Radio 'Phones. This adjustment keeps the diaphragms in place—and prevents distortion. The sensitivity of the diaphragms gives natural reproduction to voice and music.

Light and comfortable

THE Murdock weighs only 13 ounces. This extremely light weight makes it possible for the user to wear these 'phones for hours without discomfort. Ear caps are especially designed to exclude outside noises. The improved flat head-band is feather-weight, and does not bind the head. And there are no screws in the band or adjusting rods, which means added comfort to the wearer.

Over 1,000,000 Murdocks are in use today. Quantity production has enabled us to standardize our price—so that when you buy a Murdock you are sure of getting the best possible value. Get a Murdock today and test it out. It is fully guaranteed.



Built, not assembled

Murdocks are made in a single unit, of superior moulded insulation. Each part is fitted by one process into its proper place. They are moulded together — assuring firmness, strength and durability. And they can't get out of adjustment

Murdock Multiple Plug Jack

THIS effective plug jack permits the use of one to four 'phones at the same time. Get one—and let the whole family listen in.

WM. J. MURDOCK COMPANY, 373 Washington Avenue, Chelsea, Mass.
Branch Offices: Chicago and San Francisco

MURDOCK RADIO PHONES

Standard since 1904

—MAIL COUPON FOR FREE BOOKLET—

Wm. J. Murdock Co.,
373 Washington Avenue, Chelsea, Mass.

Gentlemen: Please send me, without obligation, your free booklet, "The Ears of Radio," which explains the importance of radio 'phones to efficient radio reception.

Name .....

Street .....

City ..... State .....

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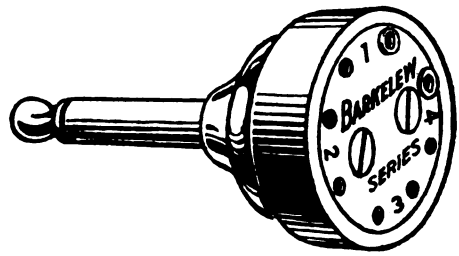
Barkelew Four-Phone Plug

PATENTS PENDING

Connects four phones or less in series to any Radio Set employing standard telephone jacks



Cat. No. 616
Price $1.50

It adds to the appearance of any set. With all phone tips adjusted, the diameter is but 1¼ inches

CHICAGO, ILL.
15 S. CLINTON ST.

BARKELEW

ELECTRIC MANUFACTURING CO.
MIDDLETOWN, —— OHIO

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Licensed under Armstrong U. S. Patent No. 1,113,149

Eleven Degrees from the North Pole

Ice—endless miles of ice, as far as the eye can see. And frozen fast in the ice, amid the deadly stillness and the unearthly lights of the Arctic, a staunch little eighty-nine foot schooner! But Donald B. MacMillan and his band of brave explorers are not alone tonight.

Under their ice-bound hatches they listen eagerly to the news of the outside world, broadcast to them from the Zenith-Edgewater Beach Hotel Broadcasting Station, Chicago—to violins in Newark, Schenectady, Los Angeles—to singers in Atlanta—to a lively orchestra in Honolulu.

Stations in all these cities—and in several hundred others—they have readily tuned in; yet the Bowdoin tonight is only eleven degrees from the North Pole!

Out of all the radio sets on the market, Dr. MacMillan selected the Zenith exclusively—because of its flawless construction, its unusual selectivity, its dependability and its tremendous REACH.

And you can do all that Dr. MacMillan does, and more, with either of the two new models described at the right. Their moderate price brings them easily within your reach. Write today for full particulars.

Zenith Radio Corporation

McCORMICK BUILDING, CHICAGO, ILLINOIS

ZENITH

TRADE MARK

Long-Distance Radio

Model 3R The new Zenith 3R "Long-Distance" Receiver-Amplifier combines a specially designed distortionless three-stage amplifier with the new and different Zenith three-circuit regenerative tuner.

Fine vernier adjustments—in connection with the unique Zenith aperiodic or non-resonant "selector" primary circuit—make possible extreme selectivity.

2,000 to 3,000 Miles With Any Loud-Speaker

With the new Zenith 3R satisfactory reception over distances of 2,000 to 3,000 miles, and over, is readily accomplished in full volume, using ***any ordinary loud-speaker***. No special skill is required. The Model 3R is compact graceful in line, and built in a highly finished mahogany cabinet $160

Model 4R The new Zenith 4R "Long-Distance" Receiver-Amplifier comprises a complete three-circuit regenerative receiver of the feed-back type. It employs the new Zenith regenerative circuit in combination with an ***audion detector*** and ***three-stage*** audio-frequency amplifier, all in one cabinet.

The Zenith 4R may be connected directly to any loud-speaker ***without*** the use of other amplification for full phonograph volume, and reception may be satisfactorily accomplished over distances of more than 2,000 miles $85

ZENITH RADIO CORPORATION,
Dept. R, 328 South Michigan Avenue, Chicago, Illinois

Gentlemen:
Please send me illustrated literature on Zenith Radio.

Name .....

Address .....

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At Last—An Authoritative, Practical Radio Book

THE OUTLINE OF RADIO

(What Radio Is and How It Works)

By JOHN V. L. HOGAN

Mr. Hogan, one of the best-known radio engineers in the United States, in his book, "The Outline of Radio," gives the history of radio from its earliest days, and describes practically all that is now known regarding the essentials of this wonderful science.

In a clear and simple way, he explains the relation of electric currents to radio waves, their characteristics and properties, and the leading and fundamental features of the operation of radio telegraph, and radio phone transmitters and receivers are succinctly and accurately described.

All the different steps in radio are discussed: transmission, modulation, and wave-propagation; reception, detection, selection, and amplification. The adaptation of radio to weather reporting, marine signaling, and other forms of public service, is clearly set forth; and the expansions of the radio art, in various applications, are interestingly forecast.

Kendall Banning, Editor of POPULAR RADIO, says: "The logical sequence in which the subjects are handled, the generous number of illustrations and particularly the simple and understandable style of diagrams which have been selected, combine to make the book remarkably easy to read and to comprehend."

Third Printing. With Illustrations and Diagrams. $2.00 at All Booksellers

Boston LITTLE, BROWN & COMPANY **Publishers**

Grebe *and* BAKELITE

TRADE MARK REG. U. S. PAT. OFF.

The character of broadcast reception enjoyed by users of Grebe Radio Sets is due, in no small measure, to the extensive use of Bakelite.

The excellence of Bakelite and the dependability of its qualities is indicated by the fact that a large majority of Radio Manufacturers choose Bakelite as insulation, and for improving and simplifying the design of their sets and parts.

Bakelite combines in ONE material the essential properties of many. It is highly dielectric and mechanically strong; it is unaffected by moisture, temperature or climatic changes; its color will not fade, even in strong sunlight; it will not warp, bloom or crack—but the most important property of "The Material of a Thousand Uses" in its relation to Radio is that of providing *permanently* effective insulation regardless of temperature or atmospheric conditions.

Write for a Copy of our Radio Booklet K.

Send for our Radio Map

Enclose 10c. and let us send you the Bakelite radio map. It lists the call letters, wave length and location of every broadcasting station in the world. Address Map Department.

BAKELITE CORPORATION

247 Park Avenue, New York, N. Y.

Chicago Office: 636 West 22d Street

BAKELITE
Condensite
REDMANOL
are the registered Trade Marks for the Phenol Resin Products manufactured under patents owned by
BAKELITE CORPORATION

THE MATERIAL OF A THOUSAND USES

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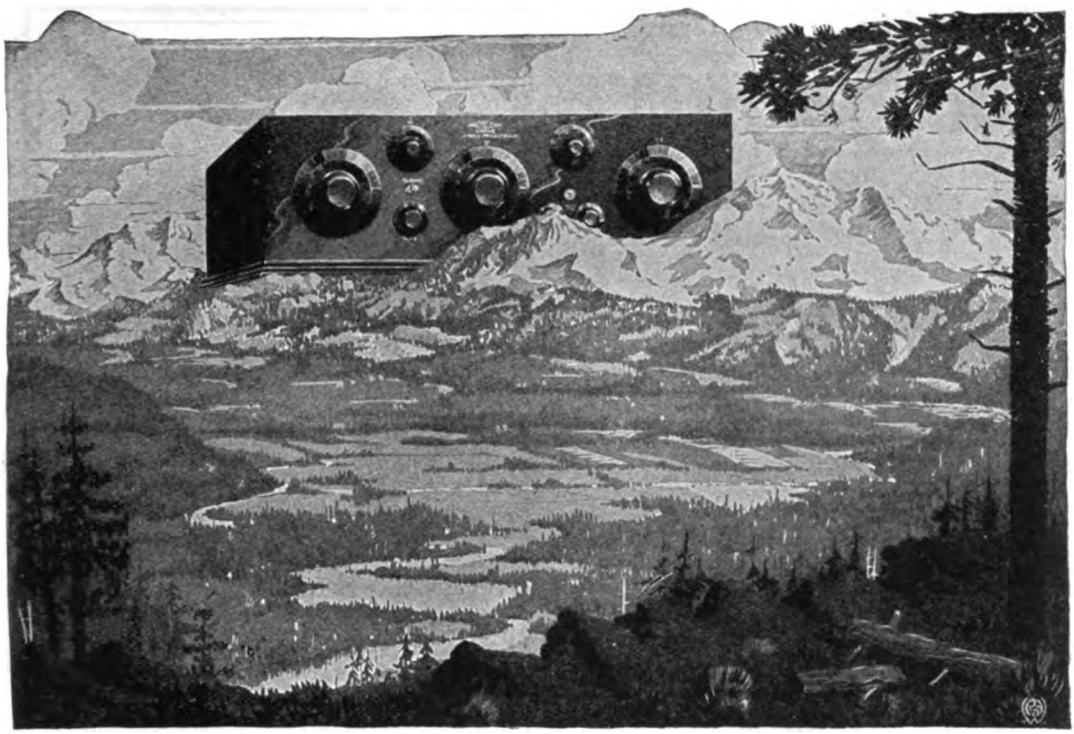

ACHIEVEMENT

FOR ages the battle between Man and Nature has gone on. The harnessing of rivers, the bridging of oceans, the conquest of space and time,—all give evidence of Man's relentless efforts to overcome the barriers which Nature sets up to challenge his skill and ingenuity.

With the unfailing courage of pioneers, Melco attacked the last barriers of the ether, bringing the treasures of the radio art within the reach of all. Today, the Melco receiver *is* supreme in its achievements.

Melco was the first to level the sinister mountains of *Interference, Distortion* and *Signal Losses.* By its improved design and intensive engineering, the Melco-Supreme has made distance reception the servant of the non-technical user. It has set new standards of selectivity and freedom from interference and its superb tone quality has captivated even the most critical.

AMSCO PRODUCTS, INC.
Broome and Lafayette Streets, New York, N. Y.

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"Wouldn't trade my

THOROPHONE

TRADE MARK REG. U.S. PAT. OFFICE

for a Rolls-Royce"

says HARRY H. HECKMAN

***High Power* Model S-5 $45.00**

COMPARISON tells. Listen to the Thorophone and learn how perfect a loud speaker can be. Every tone, every note is given its true value. You would think speaker or musician were right before you.

Make the Thorophone your permanent loud speaker investment—you'll never want to change it. The Thorophone makes any set sound better.

Made by America's oldest manufacturers of loud speaking devices. A power horn, taking only one ampere from a 6-volt storage battery. It actually amplifies weak signals, yet handles the greatest possible volume with the same natural quality—quality that satisfies.

Write for booklet

WINKLER-REICHMANN CO.

4801 S. Morgan Street Chicago, Ill.

"See! Dad

how much stronger it's coming in since you bought me

BURGESS

RADIO BATTERIES

SOMETIMES it's Dad who does the buying for his radio family, but you may be sure that that youngster of his sits in on the advisory board.

In all events, whether it be the boy or his father who buys receiving set equipment, the service of Burgess Radio Batteries provides a most satisfactory and economical means to greater enjoyment of the evening's radio entertainment.

"ASK ANY RADIO ENGINEER"

BURGESS BATTERY COMPANY

ENGINEERS · DRY BATTERIES · MANUFACTURERS
FLASHLIGHT · RADIO · IGNITION · TELEPHONE

GENERAL SALES OFFICE: HARRIS TRUST BLDG., CHICAGO
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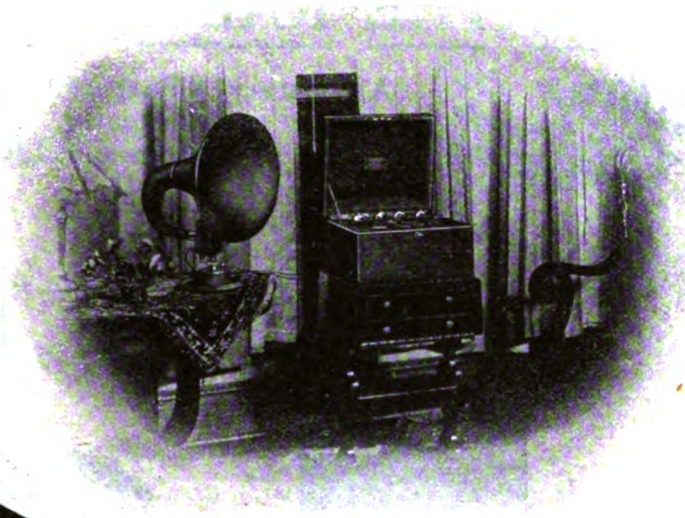
Bristol Single Control Radio Receiving Set together with Bristol Senior Audiphone Loud Speaker as used in One of the Finer Homes.



Radio Reception Simplified to Single Control Dial

It is an easy matter for any member of the family to operate a set like this. A good illustration of the absolute simplicity of

BRISTOL SINGLE CONTROL RADIO RECEIVER

is the fact that a set is installed in the home of a blind woman who operates it herself and is able to bring in station after station at her will.

Powerful enough to get reception from coast to coast. It is a four-tube set using Grimes Inverse Duplex System, which makes it equal to six tubes because the first two tubes are utilized for both Radio and Audio Amplification.

Non Reradiating—will not disturb your neighbors' reception when you tune in.

Many refinements, including panel with telephone jacks on back of the case for making connections.

Used with Aerial or Loop, and in some locations short Inside Antenna will give good results. When Aerial and Loop are both provided it is only necessary to operate a lever to change from one to the other.

The case is solid mahogany finish with walnut stain. It is handsome in appearance, and at the same time provides a rugged protection for the working parts.

Price of Bristol Single Control Radio Receiver without accessories $190.00.

BRISTOL

AUDIOPHONE

LOUD SPEAKERS

made in three models, Senior $30.00, Junior $22.50, Baby $12.50.

The most recent development in these models is the fibre horn with which the Baby Audiophone is now furnished, as illustrated below.

Write for Bulletin No. 3013-L

MADE AND SOLD BY

THE BRISTOL COMPANY

Waterbury, Conn.

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KEEPS THE RADIO SET ALIVE

HANDY CHARGER

A Battery Charger that gives a quick charge economically. No Sticking Contacts. No bulbs nor Liquids. Fully enclosed — beautiful.

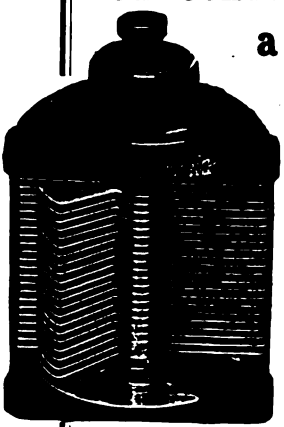
SIMPLEX MODEL — For 6 volt Batteries only. The Most Practical, Most Complete Battery Charger, for only **$16.00**

ULTRA MODEL — Charges Them All. Charges 2 volt, 4 volt, 6 volt, 8 volt, 10 volt, 12 volt and 1 to 4 "B" Storage Batteries, with WESTON AMMETER, **$18.00**

All prices f. o. b. St. Louis

INTERSTATE ELECTRIC COMPANY *of St. Louis, Mo.* 4015 Laclede Avenue

Your Condenser Makes a Difference



Pick up those distant stations louder and clearer. Eliminate noise and interference. Get more pleasure out of your receiving with

Elgin

Elraco Precision Condensers

Fully Guaranteed

Size	Capacity	Plain	Vernier
3 Plate	.000063 M. F.	$1.75	
11 Plate	.00025 M. F.	2.40	$4.00
17 Plate	.00035 M. F.	2.75	
23 Plate	.0005 M. F.	3.00	4.50
43 Plate	.001 M. F.	4.00	5.50

3" diameter composition dials, 50c extra

See your local dealer. If he cannot supply you send his name with your order to

Elgin Radio Corporation

***Radio Division of* The Elgin Tool Works, Inc.**

69 No. State St. Elgin, Illinois

"Hard to Get" Parts

We specialize in parts for hook-ups published in this magazine. Here is a list of "hard to get" parts we can ship from stock.

Genuine Cockaday coils	5.50
Amsco 26 Plate Condensers	4.50
AmerTran Transformer	7.00
Como Push & Pull "pair	12.50
Lavite Resistances	1.50
Parts for Special Variocoupler and Radio Frequency Transformer (for Craig Neutrodyne receiver)	3.25
Cardwell 21-Plate Condensers	5.00
" 41- " "	6.00
" 11- " "	4.25
Dubilier .0025 Condensers	.40
General Radio Transformers	5.00
Alden Napier Products:	
Amsco Products:	
Acme Celatsite Wire—30 inch lengths each	.25

Try us on ANY radio parts you have been unable to secure: Mail orders will be shipped promptly.

Morison Electrical Supply Company, Inc.

15 East 40th Street New York City

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Super-Heterodyne

Resistance Coupled — No Transformers

The New Improved Type Employing Resistance Coupling for Broadcast Reception

Free from Distortion — **Write for Details**

Cockaday Four Circuit Receiver

Special Service to Builders

of the New Improved Four Circuit Receiver as Described in **January Popular Radio**

Complete Parts for the Four Circuit Receiver **$59.00**

Drilled Machine and Engraved Bakelite Panel according to **Cockaday's** Specifications **$6.50**

Genuine P. L. Resistances

The Original in the following Capacities

For COCKADAY, REINARTZ, SUPER-HETERODYNE and FARRANDS' SUPER-PLIODYNE CIRCUITS

1,000 Ohms	30,000 Ohms
12,000 Ohms	48,000 Ohms
20,000 Ohms	50,000 Ohms
25,000 Ohms	80,000 Ohms
100,000 Ohms	

List Price $1.00

Dealers: Write for Discounts

All Mail Orders Shipped Promptly ***Send Money Order, Including Postage***

WRITE FOR OUR NEW CATALOG "G"

HANES-ZENER CO

The Radio Mail Order House—Where you get the right goods at the right Prices

1480 BROADWAY, CORNER 42nd STREET

LONGACRE BUILDING **NEW YORK CITY**

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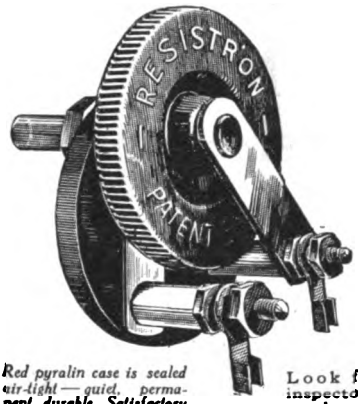
The Precision Variable Grid Leak



Red pyralin case is sealed air-tight — guid, permanent, durable. Satisfactory results guaranteed.

Look for inspector's number on the label.

Resistron
Two Dollars

Maybe your detector tube is playing 'possum. RESISTRON will make it "snap out of it." Turning the dial picks the point of greatest sensitivity. Then the tube wakes up, stretches for DX — and gets on the job, increasing your list of stations. Try it!

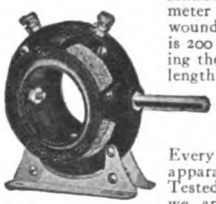
If your dealer cannot supply you we will ship parcel post C. O. D.

TEMPLE INSTRUMENT COMPANY
Camden, New Jersey

Coto
"Built First to Last"

"So Much Better than you claimed it to be"

So says one of the users of Coto Compact Moulded Variometer. Letters from all quarters praise this remarkably efficient variometer with the honeycomb wound stator coils. Range is 200 to 600 meters covering the broadcasting wavelengths. Type 8000. $5.



Read Our Guarantee

Every piece of Coto Radio apparatus is Laboratory Tested before shipment. So we are perfectly safe in authorizing dealers and jobbers to guarantee you absolute satisfaction.

If your Dealer cannot supply you, send us your order and his name and address

COTO-COIL CO. 87 Willard Ave. Providence, R. I.

Los Angeles, 329 Union League Bldg.
Minneapolis, Geo. F. Darling, 705 Plymouth Bldg.
Atlanta, C. P. Atkinson, Atlanta Trust Co. Bldg.
Canada, Perkins Electric Co., Ltd.
Montreal, Toronto, Winnipeg

DUPLEX

PATS. PEND.

Series "FR" Condenser

In this model we have, we believe, made a distinct contribution to the art.

TRADE MARK NONE OTHER

Mechanically perfect. We have reduced the electrical losses to an immeasurable minimum.

Some profitable jobber territory still open.

Write for Bulletin "Facts for Fans" on Condensers

The DUPLEX ENGINE GOVERNOR CO., Inc.
50 Flatbush Ave. Extension
BROOKLYN, N. Y.

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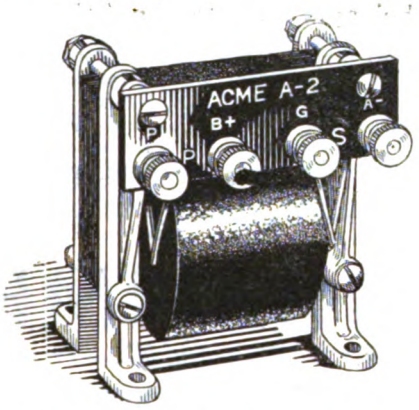
To get amplification without distortion—use ACME

Thousands of radio owners find Acme Transformers give louder, clearer radio. Letters from users show increased range—"amplification without distortion," important factor in success of Acme audio and radio frequency transformers.



ACME A2 for volume

"MY RANGE at once increased so that I get stations that I never got before," writes one amateur who installed Acme transformers in his set. Thousands of amateurs who have experimented with different hook-ups and different apparatus to get the best results insist on Acme transformers.

Acme transformers are the result of long research by the Acme Apparatus Company, specialists in the manufacture of amplifying transformers. When broadcasting was in its early stages Acme engineers recognized that "Amplification is the key to radio." They set out to make the Acme amplifying transformers give maximum amplification without distorting the sound. So well did they succeed that today Acme transformers are the most popular transformers made.

The Acme R-2, 3 and 4 Radio Frequency Amplifying Transformers increase range. Acme A-2 Audio Frequency Amplifying Transformer gives greater volume to any set ***without distortion***. The ratio is 4.25 to 1 and exhaustive tests show that this is the correct ratio, even for three stages.

Rigid inspection means uniform apparatus

TRAINED inspectors in the Acme factory, carefully test each transformer before it leaves the factory. This means that each piece of Acme apparatus is up to Acme standard when it reaches you. Every transformer carries a guarantee tag— but the best guarantee is the name Acme.

Send for booklet

OUR booklet, "Amplification without distortion," clearly explains how to get the most out of your set by using the proper amplifying apparatus. It contains diagrams for the Acme "Reflex" circuit. Mail the coupon for your copy.

ACME APPARATUS COMPANY
Dept. 43 *Cambridge Mass.*

ACME
~ for amplification

ACME APPARATUS COMPANY
Dept. 43, Cambridge, Mass., U. S. A.
Gentlemen:—I am enclosing 10 cents (U. S. stamps or coin) for a copy of your book, "Amplification Without Distortion" containing wiring diagrams for the Acme "Reflex" Circuit.

Name.....
Street.....
City.....*State*.....

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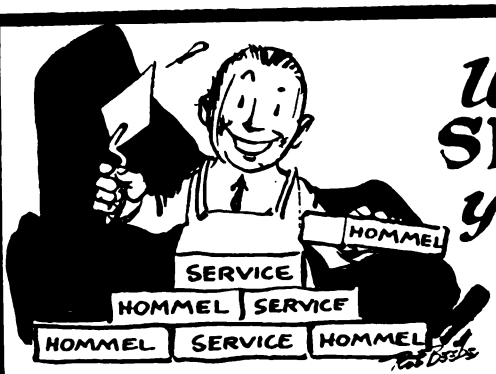

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Complete stocks of strictly high grade nationally advertised radio apparatus are constantly carried by this Company to enable you to build your radio business on the right foundation. Your success is dependent largely on the products you sell, and your ability to serve your customers promptly.

Aligning yourself with the HOMMEL organization makes it possible for you to always have access to ample stocks of the leading lines of radio equipment without the necessity of tying up your working capital.

Let us show you how you can advantageously use Hommel Service. Write for encyclopedia 246-P

LUDWIG HOMMEL & CO

530-534 FERNANDO ST. — PITTSBURGH, PENNA

COAST TO COAST

on the R.C.S circuit, using

RayCoils

RayCoils "A" for Reinartz, Ray Coils "B" for RCS and Ultra Audion Circuits, RayCoils "C" for RCS, Ultra Audion and Tuned Radio Frequency for All Circuits. RayCoils "D" for Neutralizing Circuits 4 & 5 Tubes.

A = $2.50
B = 2.00
C = 2.00
D = 2.00

Use the RCS Circuit with or without Radio Frequency for Simplicity in operation and results. Not equalled by any set for volume and distance.

Coils in Separate Box With Wiring Diagram

Working **Blue Prints** of four sheets 12 x 18 of all standard circuits, such as The Variometer, Reinartz, RCS one and three tube sets and five tube Neutralizing Circuit 50 cents a set.

We also carry a complete line of Carter, Howard, Kellogg, All American and Trimm parts.

If your dealer cannot supply you, we will mail direct.

R. C. SCHOONHOVEN
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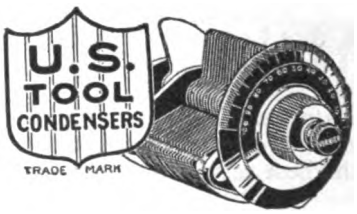

Approved by Public Demand

The huge sale of **U. S. Tool Condensers** proves that these condensers are RIGHT.

100% Guaranteed

End Plates of
CELORON

For Superheterodyne, Superdyne, Inverse Duplex, New Four Circuit Tuner

Use Vernier Cap. .00057 Mfd. (24 Plate) or Plain Cap. .00055 Mfd. (23 Plate)

Condensers of recommended capacity for all known circuits are also carried in stock by leading radio retailers.

Write for Booklet

U. S. TOOL CO., Inc.

116 Mechanic St. Newark, N. J.

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Boys' radio interest knows no "off season"

THE HARDER the battle the sweeter the triumph. That's part of every live boy's code. And when it comes to radio, the greater the difficulties the more he strives to overcome them, or failing that, to succeed in spite of them. This spirit of boydom, together with the unquenchable enthusiasm boys have for radio, is the radio manufacturer's bridge across the summer doldrums.

No matter where a boy goes—to camp, the mountains or the shore—he's sure to have two things with him: His appetite and his radio set. And each trip to the general store has a double purpose—soda for the appetite, and some new device for the beloved radio. The desire for one is as unremitting as the desire for the other. The volume of sales for both is amazing.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

is guide and authority to 500,000 radio-hungry boys averaging 15½ to 16 years old. These boys are sons of well-to-do parents, possessors of substantial allowances with which to buy desired objects. And all through the summer this great army of boys will be buying radio equipment.

Advertise your radio products to them. Tell them not only of the goodness and up-to-dateness of your products—tell them of your distribution, and how they can get your goods wherever they spend the summer. Start them using your name—and thinking about radio in terms of your name. Keep your name and your product constantly before them in the one great publication they know to be their own—THE AMERICAN BOY.

THE SPRAGUE PUBLISHING COMPANY

(Member A.B.C.)

548 Lafayette Boulevard, Detroit, Michigan

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Bakelite Jack

No. 30–Single circuit open $.80
No. 31–Single circuit closed .85
No. 32–Double circuit..... .90
No. 33–"A" Battery Switch .90

Every CICO PRODUCT is packed in a distinctive GREEN BOX and unqualifiedly guaranteed against all defects.

2-Way Plug

Price 60c

WHY CICO PRODUCTS LEAD THE FIELD

CICO Bakelite Jacks

Moulded completely from Bakelite. Connections made to neat binding posts. Smaller and more compact than other jacks. Special phosphor bronze springs. Sterling Silver contact points. Mechanically and electrically perfect in every detail.

CICO

CICO 2-Way Plugs

Constructed so that loud speaker and head-phones can be connected simultaneously or individually as you wish (note two slots in each terminal). Fit all standard jacks. Take all types of tips, forked, straight and plain wire. Sturdily made and finely finished.

Consolidated Instrument Co. of America, Inc.
41 East 42nd Street, New York

Announcement
of prize-winning name to replace "Acmedyne"

TELOMONIC

WELL over 1000 names were suggested in the contest for a circuit name to replace "ACMEDYNE."

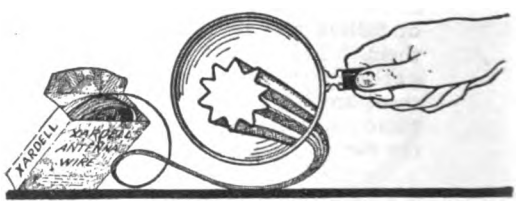
The judges, Charles Hardy, S. E. Bramer, R. H. Butler, H. I. Danziger, and Lester L. Jones, after careful deliberation, selected "TELOMONIC" as most expressive of this principle of tuned R. F. amplification.

The winner, Dr. M. Ohlbaum, receives a complete knock-down set of the essential Telos instruments for the TELOMONIC circuit.

Danziger-Jones, Inc. desires to express sincere thanks to all those who participated in this contest.

TELOS **RADIO**

DX-10-POINT



ANTENNA WIRE

$2.00

PER HUNDRED FEET

Designed for long distance reception and is different and better than the usual make-shifts, being hard drawn from the finest copper, having a corrugated surface with ten collecting points on the circumference. This gives a greater collective surface to the high frequency radio currents. The result is extreme sensitiveness and increase in range and clearness of any set from the simplest Crystal to the finest multiple tube receiver.

Use this antenna wire and enjoy the full possibilities of your set.

Sold in coils 100 feet, 200 feet and 500 feet. Order direct or from your nearest dealer.

Dept R

Xardell Corp.
UTICA, NEW YORK

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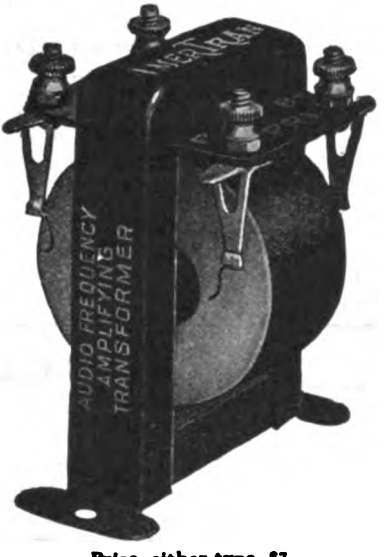
Announcing

TYPE AF-7 (Turn ratio 3½)

AMERTRAN

TRADE MARK REG U.S. PAT. OFF.

Improve your set with an AmerTran



Price, either type, $7.
—at your Dealer's
or sent carriage charges collect

This summer you will be able to enjoy radio as never before

THE AmerTran, Type AF-6 (Turn ratio 5), has long been acknowledged the Standard of Excellence for audio amplification.

Type AF-7 (Turn ratio 3½), is now, after long study and experiment, offered in response to the demand for a companion transformer for second or third stages of sets provided with powerful regeneration or radio frequency amplification and more especially those sets wherein one AF-6 does not give sufficient volume under all conditions, and 2 stages are too powerful for the tubes unless negative biasing batteries are used.

Type AF-7, like AF-6, provides an unusually flat amplification curve with well sustained amplification at very low audio frequencies. It is not intended as a substitute for AF-6, but where a low turn audio transformer must be used, nothing has been sacrificed in making Type AF-7 the very best for its purpose.

Type AF-6 is finished in black and is packed in a box printed in dark blue. Type AF-7 is finished in brown and packed in a box printed in red.

Send for Circular

American Transformer Co., 175 Emmet Street, Newark, N. J.

Designers and builders of radio transformers for over 23 years

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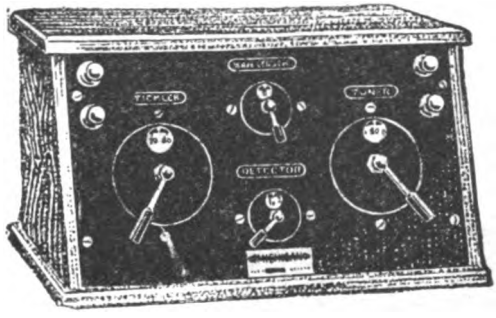


MICHIGAN MIDGET

$27

Michigan One-Tube Receiving Set has no equal for range, clearness, selectivity or volume. The same stations always come in at the same dial numbers.

Pleases the Whole Family

It pleases the boys, for they can out-distance their friends—no matter what set they've got.

It pleases the girls, for they can quickly tune into any station—The Midget is simple to operate, nothing difficult.

It pleases Mother because its attractive appearance does not spoil the setting of her room. And when cells are used there is no fear of acid spoiling her rugs or floor. Mother also can enjoy cooking lectures and afternoon concerts, for she can soon tune in her station.

It pleases Dad, for he has to pay the bill.

Nothing to equal the Midget has ever been offered at anything like the price. It will do anything any other set will do, and costs about half as much. Yes, sir—the whole family is pleased, and Dad, he too, soon tunes in, enjoying himself till Mother calls him to bed.

Distance
Volume
Selectivity
Simplicity

Licensed under Armstrong U. S. patent, 1,113,149 and pending letters of patent 807,388.

MICHIGAN RADIO CORPORATION

34 Ottawa Street
GRAND RAPIDS, MICHIGAN

The B-T
Prize R-F Circuit

can be built up and tested *on the air* step by step.

This method insures success.

It is non-regenerative and does not re-radiate.

Write for circular

BREMER TULLY MFG. CO.
534 So. Canal St.
CHICAGO

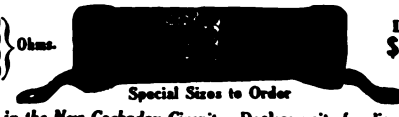
GOLDWHISKER

Gets Greater Distance. Pure gold makes the best contact known. We guarantee a GOLDWHISKER for greater range and louder signals out of any crystal. 50c prepaid—send coin or stamps, or we'll send C. O. D.

REP RADIO CO.
Dept. N-2 3231 Nebraska Ave., St. Louis, Mo.

CRESCENT LAVITE RESISTANCES

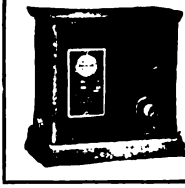
12,000
48,000
50,000
100,000
} Ohms.



LIST $1.50

Special Sizes to Order

Used in the New Cockaday Circuit. Dealers write for discount.
CRESCENT RADIO SUPPLY CO. 1-3-5 Liberty St., Jamaica, N. Y.



Charge Your Battery For A Nickel

The Gold Seal Homecharger charges Radio and Auto Batteries at home **overnight** for a nickel. Your dealer has it. Write for FREE booklet and list of broadcasting stations.

The Automatic Electrical Devices Co.
132 West Third St., Cincinnati, Ohio

RUSONITE
FIXED DETECTOR

TONE ADJUSTER - BAKELITE BASE

Guaranteed. Price $1.25

Rusonite Perfect Radio Crystal Supersensitive. Price, Mounted, 50c
Rusonite Catwhisker 14k. Gold, 25c

Rusonite Products Corporation
15 Park Row, New York, N. Y.

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The CLEAR Loud Speaker!

Herald

THE Herald **stands up under power** without rattling. **Like other good** musical instruments, **it improves with age** because of its laminated core, mica diaphragm and permanent magnet. **The** adjustable diaphragm **makes it possible** to get the most **out of a weak set. Height** 30 inches, 6-foot **cord. Price $30. Slightly** more on Pacific **Coast and in Canada.** Write for folder **and enclose your dealer's** name.

Herald Electric Co., Inc., 113 Fourth Avenue, New York

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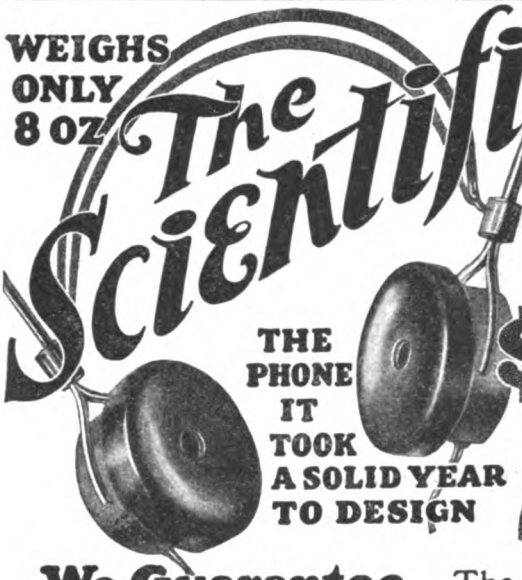
WEIGHS ONLY 8 OZ

The Scientific



THE PHONE IT TOOK A SOLID YEAR TO DESIGN

A $200,000.00 COMPANY stands squarely back of the guarantee on every *Scientific* headset

SEND NO MONEY!

20,000 TURNS EQUIVALENT TO 3,000 OHMS

$2.95 POST-PAID

Order TODAY by Postcard and Pay Postman on arrival

LOUD SPEAKER UNIT $1.95

We Guarantee The *Scientific* Headset to be the greatest value on the market. Try it for five days. If not satisfactory send it back and your money will be refunded immediately. Circular on request. Dealers wanted.

THE SCIENTIFIC ELECTRIC WORKS

98 Brookline Ave. DEPT. J BOSTON, MASS.

CIC

LOUD SPEAKING UNIT

(Phonograph Attachment)

$6.50

Floating Mica Diaphragm

Loud—Clear—Natural

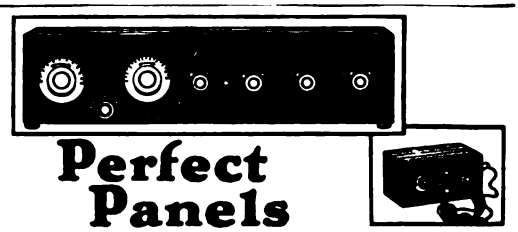
C. I. C. Loud Speaker with 20″ Acoustene Fabric Horn—the latest and best. . **$16.00**

All C. I. C. instruments are unconditionally guaranteed.

If your dealer cannot supply you order direct from us.

Connecticut Instrument Co.

Stamford, Conn.



Perfect Panels

for any set, big or little!

SUPREME for super-heterodyne or single circuit! No other material known possesses the many combined advantages of Bakelite-Dilecto for radio paneling! Tell it by its center red stripe.

bakelite-dilecto

(A Laminated Phenolic Condensation Material)

Once the installation is completed, Bakelite-Dilecto panels remain absolutely unchanged, no matter what abuse it is given by heat, cold, water, steam, oil, solvents and weather elements. They do not warp, swell, shrink, crack, check or split. Highest in dielectric strength. Surpassingly tough, yet readily machined. Your dealer can get it cut and drilled to fit your needs.

THE CONTINENTAL FIBRE CO.

Factory: Newark, Delaware

Service on Bakelite-Dilecto (also Continental-Bakelite, Conite, Contex and Vulcanized Fibre) from:

New York, Woolworth Bldg. Chicago, Wrigley Bldg.
Pittsburgh, 301 Fifth Ave. San Francisco, 75 Fremont St.
Los Angeles, 307 S. Hill St. Seattle, 1041 Sixth Ave., So.

Offices and Agents Throughout the World

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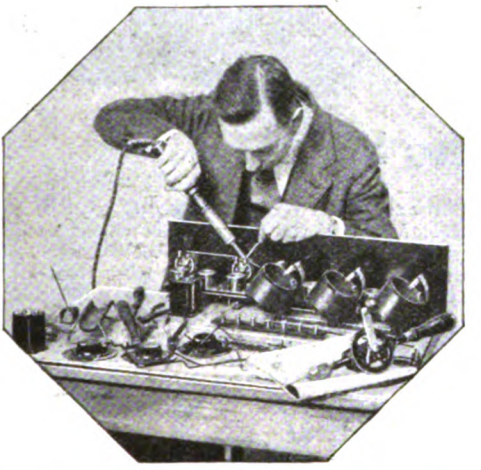
Get This Book!
"How to Build Neutrodyne Radio Receivers"

This 48-page book is the standard authority on making five-tube Neutrodyne receivers. Fully illustrated with picture wiring diagrams and a full-size drilling template for a five-tube receiver. Complete instructions on assembly, wiring, neutralizing and tuning. Also includes detailed trouble-shooting information. Sent post-paid anywhere in the U. S. for 50 cents. Write for this new edition today.



FADA Knock-Down Parts for Five-tube Neutrodyne Radio Receivers

165-A—Three Neutroformers and two Neutrodons with "How to Build It" book. The heart of the Neutrodyne receiver—$35.00.

167-A—Everything for five-tube set down to last screw and binding post. Complete with book, panel, baseboard, sockets, telephone jacks, audio frequency transformers, Neutroformers, Neutrodons, etc.—$65.60.

Ask your dealer for FADA parts.

Make yourself a FADA Neutrodyne receiver and enjoy the best in radio

THOUSANDS and thousands of successful Neutrodyne receivers have been built by radiophans using only FADA Neutrodyne parts. With the famous FADA "How to Build It" book (over 150,000 of which have been sold) anyone can build a five-tube Neutrodyne receiver that will amaze by its fine performance.

FADA Neutrodyne receivers have made wonderful records for distance and volume, for selectivity and ease of operation. A resident of Forrest Hills, Long Island, writes, "Heard London and Glasgow on loud speaker evening of March 13th with FADA five-tube set."

Because the Neutroformers and Neutrodons require special engineering design, they are naturally the heart of the receiver. FADA parts are made accurately to scientifically correct specifications—they've got to be right and *are* right before they pass our rigid standards of inspection.

If you want to own the most satisfactory radio receiver, buy FADA Knock-Down parts and build yourself a five-tube Neutrodyne receiver. Get genuine FADA parts—don't take unknown parts and expect them to work. Dealers everywhere sell genuine FADA Neutrodyne parts—look for the name and trade-mark on every package.

F. A. D. ANDREA, INC., 1581 Jerome Avenue, New York City

FADA Radio

F. A. D. ANDREA INC. LICENSED BY INDEPENDENT RADIO MANUFACTURERS, INC. NEUTRODYNE

F. A. D. ANDREA, INC., 1581 Jerome Avenue, New York City

Gentlemen: Enclosed find fifty cents { ☐ Stamps / ☐ P. O. Order } for which send me your book on "How to Build Neutrodyne Receivers."

Name.....

Street Address or R. F. D.....

City or Town.....State.....

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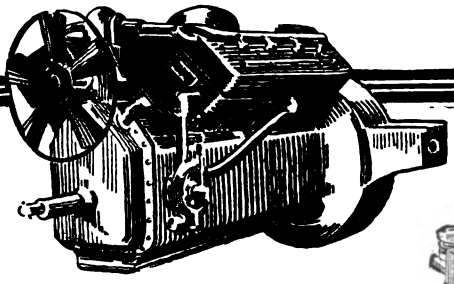


The Engine of Your Radio Set

WOULD you select a two-cylinder engine for pleasure driving? Would you use a marine engine to propel a motor truck? Would you use an air-cooled, aeroplane engine in a racing car? When you select audio transformers without considering their qualities you are putting the wrong engine in your radio set.

Supertran high speed smoothness with multi-cylinder reserve power makes it an ideal audio engine to drive your loud speaker. It represents the best engineering because you have no back-fire distortion or poor timing regulation to introduce howling.

Ford Mica Co.
33 East 8th Street
New York City

SUPERTRAN

New England Distributor:
Wetmore-Savage Co., Boston, Mass.

Midwest & Southwestern Distributors:
Beckley-Ralston Co. Chicago, Ill.

Reg. U. S. Pat. Office

BLUE SEAL GUARANTEED PRODUCTS

Howard

Radio Co. Inc. Chicago, U.S.A.

HOWARD

No. 1001
6½ Ohm Rheostat..... $1.10
25 Ohm Rheostat..... 1.10
40 Ohm Rheostat..... 1.10
Patd. 870,042

HOWARD

No. 1003
200 Ohm Potentiometer. $1.50
400 Ohm Potentiometer .2.00
Patd. 870,042

Ask the man behind the counter to show you the **Howard** line of quality Radio Merchandise. Every piece is sold with the **guarantee** of satisfactory performance.

Jobbers write for discounts.

Send two cents for folder.

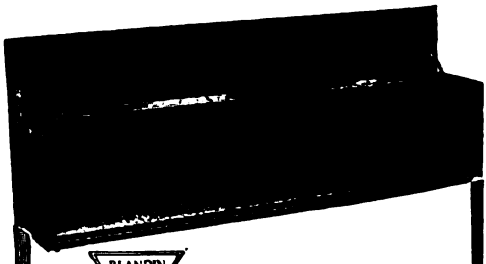
HOWARD

No. 1002
6½ Ohm Micrometer Rheostat.... $1.50
25 Ohm Micrometer Rheostat..... 1.50
40 Ohm Micrometer Rheostat..... 1.50
Patd. July 10, 1923

HOWARD

No. 1004
Multi Terminal Receiver Plug, instantaneous connection for as many as six pairs of standard receiver tips..... $2.00
Patd. Aug. 28, 1923

HOWARD RADIO CO., Inc.
4248 North Western Ave., Chicago, U. S. A.



BLANDIN TRIPLE A

And NOW
Super Radio Cabinets

Panel size 8 x 40-8 inches deep. Made of solid select mahogany with basswood bottom, varnished and hand rubbed to a piano finish. Built by experienced workmen—experts on cabinet design and construction.

BLANDIN TRIPLE "A" DE LUXE SERIES

Full De Luxe equipment including extra mounting board—inlet flush lid—continuous piano hinge—folding lid supports—rubber feet.

Also Neutrodyne sizes, 7 x 24-7" and 7 x 26-7". Smaller sizes, 7 x 14-7", 7 x 18-7" and 7 x 21-7". Write for illustrated price list and name of your nearest jobber or dealer.

Jobbers and dealers, write for discounts

BLANDIN PHONOGRAPH COMPANY, INC.
1500 16th St. :: :: RACINE, WIS.

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NEWS OF MARATHON

AFTER the great battle of Marathon, 490 B. C., between the Athenians and Persians, a runner named Phidippides carried news of the Greek Victory to Athens about 25 miles away. So great were his exertions that, delivering the message, he fell dead. Our annual Marathon race commemorates this event.

Radio now enables us to learn of great events almost instantaneously. This great agency of enlightenment is available to anyone possessing a receiving set, but for its true enjoyment, only the best in Radio instruments should be used.

The Holtzer-Cabot Electric Company has spent years in scientific experiment and development, so that its Loud Speakers and Headphones faithfully reproduce the messages which come to us through the air.

Holtzer-Cabot Loud Speaker	**$25.00**
Loud Speaker Phonograph Attachment	**10.00**
No. 2 Universal Headphones	**9.50**
No. 4 National Headphones	**6.00**

Write for booklets explaining how the exclusive features of these instruments enable you to enjoy the wonders of Radio

THE HOLTZER-CABOT ELECTRIC CO.

125 Amory Street, **Boston, Mass.**
6161-65 South State Street, **Chicago, Ill.**
Department B-1

Holtzer-Cabot

BUSINESS ESTABLISHED 1875

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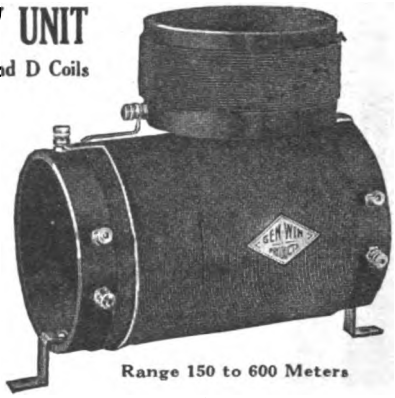
GEN-WIN TRADE MARK PRODUCTS

COCKADAY UNIT

Full Set A, B, C and D Coils

Made strictly in accordance to Mr. Cockaday's Specifications



Range 150 to 600 Meters

For 1, 3 and 5 Tube Set

Price $5.50

Best quality Radion hard rubber tubing ¼" wall wound with No. 18 double silk covered wire.

Three Large Blue Prints, Illustrated Instructions, and Material Lists for Building the 1, 3 and 5 Tube Cockaday Sets. Price 50c

(Free with order for unit)

Guaranteed mechanically and electrically perfect. The outstanding features: Complete set of A, B, C and D Coils with beautifully knurled binding posts, eliminating loose end wires, insuring perfect contact and easier wiring. Made of the best quality material combined with expert workmanship. Distributed capacity or leakage and dielectric losses practically eliminated. Insures selectivity with maximum sensitivity and volume.

Unconditionally Guaranteed to Give Absolute Satisfaction

At Your Dealer, Otherwise Shipped to You Postpaid

Dealers and Jobbers Write for Attractive Proposition

GENERAL RADIO WINDING CO.

214 FULTON ST.
NEW YORK, N.Y.

Radio Wherever You Go

Vacation — Outing — Touring

This year go with **Radio.** Camp, fish, hunt, tour with **Radio.** Make your vacation complete. Liven up the rainy days and long, dull evenings. Take the new, wonderful **Ozarka Portable, Long-Distance Receiver** with you. Get the sports returns—the concerts—the special features of hundreds of broadcasting stations. And, best of all, you'll have it for home use when you return. **Ozarka** is built for long distance—1000 miles is not unusual. Simple to operate. Convenient and light to carry. Only weighs 15 lbs. complete. Case is 16x10x5 inches. Completely equipped with aerial, "A" and "B" Batteries, three No. 199 tubes, and one set of head phones. Ready for instant use. Price complete ready to listen in $65.00. Extra phones $5.50. Big demand. Order at once. Send $10.00, pay balance on delivery. Satisfaction guaranteed.

Local Representatives Wanted

Ozarka Radio offers the greatest opportunity to make money. Big market—easy sales. Over **1800 Ozarka Agencies** now doing wonderful business. Some territory now open. You're interested, so write today for the **"Ozarka Plan,"** but don't fail to give name of your county.

OZARKA, Inc., 67 N. Peoria Street, CHICAGO

A True-tone Non-Directional Ornamental Solid Mahogany Loud Speaker

Ask Your Dealer or Write Us Direct

TYPE B FRUIT BOWL

The

VAN-LE

REPRODUCER

(Pat. App. for)

Mfd. by

VAN-LE CORP'N
100 Sip Ave., Jersey City N. J.

AN INTERESTING AND ATTRACTIVE PROPOSITION FOR DEALERS

WRITE FOR DETAILS

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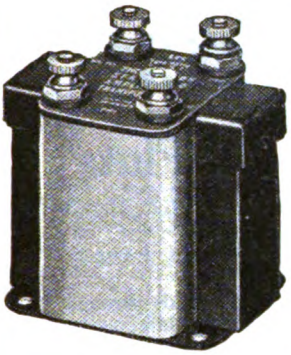

YOUR SET WILL BE A MUSICAL INSTRUMENT

WHEN YOU USE

THE THORDARSON SUPER

AUDIO FREQUENCY AMPLIFYING TRANSFORMER

Heretofore, amplifying transformer manufacturers have given too much attention to volume of amplification and have sacrificed the most important function of their transformers,—that of perfectly reproducing the broadcasted programs. Consequently many listeners in have complained about the musical qualities of radio reception.

No matter how good your phonograph, you could not expect to obtain good music from a poor record. Likewise, although your loud speaker be the best, you cannot expect to enjoy radio reception if the signals you put into it have been distorted in the process of amplification.

The new THORDARSON SUPER Audio Frequency Transformer was designed to correct the shortcomings of amplifying transformers of the past and embraces the following cardinal features:

(1) **Perfect reproduction of voice and instrument**
(2) **Even amplification over the entire musical range. (You will be surprised to hear the amazing reproduction of the bass notes.)**
(3) **Increase in volume to the extent that tonal purity will permit.**

This SUPER TRANSFORMER is the result of several months research work in the thoroughly equipped Thordarson laboratory and represents the culmination of twenty-eight years experience in manufacturing small transformers.

Such leading set manufacturers as the Colin B. Kennedy Company, Chicago Radio Laboratories Company (Zenith) and the Western Coil and Electric Company (Radiodyne) along with many others proclaim the merits of the THORDARSON SUPER TRANSFORMERS.

Install a pair of Thordarson Super Transformers now and your receiving set will be converted into a real musical instrument.

Even Amplification over the entire musical range

THORDARSON
ELECTRIC MFG. CO.

CHICAGO, ILLINOIS

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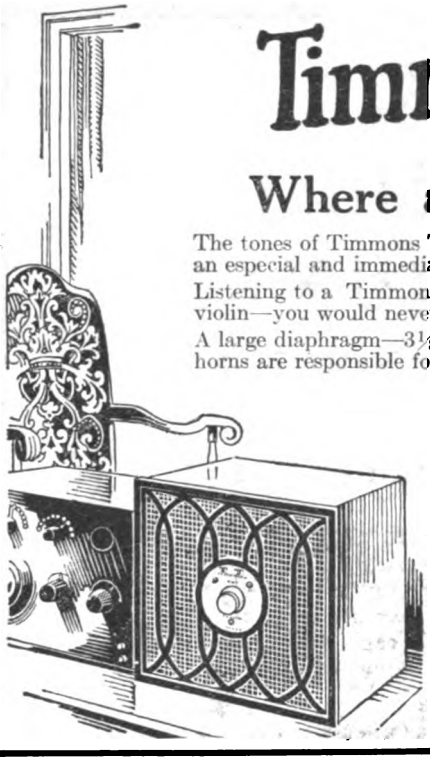


Timmons Talkers

Where a Violin is not a Flute

The tones of Timmons Talkers are so natural, rich and vibrant that they make an especial and immediate appeal to musicians.

Listening to a Timmons Talker you hear a flute as a flute and a violin as a violin—you would never mistake one for the other.

A large diaphragm—3⅛ inches—and the "reflecting" of all sounds through two horns are responsible for the deep, pleasing naturalness of the Timmons' tones.

But you'll have to hear a Timmons Talker to appreciate this naturalness. In doing this we are asking you to make your loud speaker choice in your own home. Don't make a five minute choice, take an entire evening.

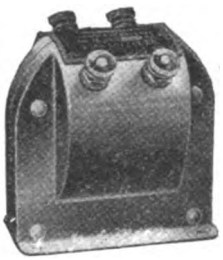
We'll be glad to help by sending an illustration detailing how a loud speaker works. We'll also send our folder "Volume Without Noise."

Type A (adjustable), $35
Type N (non-adjustable), $25

J. S. TIMMONS
339 E. Tulpehocken St. Germantown, Phila., Pa.

For Best Tone Quality—and Distance

Use the "BLUE STAR"
Audio-Frequency-Amplifying-Transformer



Better Built—Quality and Material

Our Standard Ratio 4-1

List Price Five Dollars

The Transformer that Equalizes Tone and Volume; prevents distortion from unnecessary causes.

Multiply the pleasure of your set by installing a "Blue Star Transformer."

DEALERS: Write us for our sales proposition

STAR SUPPLY CO.
1512-1516 So. Wabash Ave., Chicago, Ill.

World's Greatest BATTERY BARGAIN

Written 2 Year Guarantee Your Proof of Satisfaction

FREE Hydrometer and 45V. "B" Battery

SAVE 50%

Thousands of POPULAR RADIO Readers will profit by this amazing offer. They will buy the famous 2-year guaranteed World battery at the lowest price ever quoted—They will get a hydrometer and a 45V. "B" Battery FREE. And they get the best battery built. It is "World" quality that makes possible our 2-year ironclad guarantee. It is "World" quality that makes "World" owners "tell their friends"—that's the best proof of performance any product can have.

Compare These Prices:

Special 200 Hour Rechargeable Storage Batteries	6 Volt 60 Amp...$8.50
2 Volt for W.D. 11 and 12 tubes.....$5.00	6 Volt 80 Amp...10.00
	6 Volt 100 Amp...12.50
	6 Volt 120 Amp...14.50
4 Volt for U.V. 199 tubes 8.00	6 Volt 140 Amp...16.00

Send No Money

You need not send a penny. Just clip this ad and attach your name and address. The battery will be shipped to you the day your order is received. When the battery arrives, inspect it—read our 2-year guarantee before paying C. O. D. charges. Convince yourself you are protected from every angle—that the World battery price saves you 50%. Get the 45V. "B" Battery and hydrometer FREE. Order today.

Special Offer

Clip and mail this ad with your World battery order and get this hydrometer and 45V. "B" battery for 5% disc. for cash in full with order.

WORLD BATTERY CO.
Dept. 3, 1219 So. Wabash Ave., Chicago, Ill.

World

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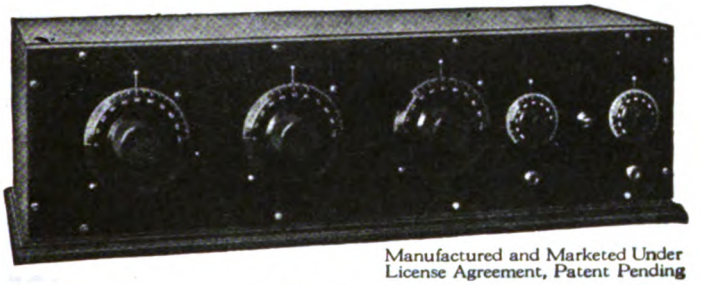
Pathé
REG. U.S. PAT. OFF.

"MINUTE MAN"

Radio Receiving Set

incorporating

Pathé Type "P" Phusiformers



Manufactured and Marketed Under License Agreement, Patent Pending

Price $125.00
(tubes, batteries extra)

THE new five-tube "Minute Man" was specially constructed to meet the demand for a receiving set embodying these features:

NO SQUEALS

Tune in either with a loud speaker or head phones without any squeals or rasping. At any setting of the dials there is none of the unpleasantness so prominent in many other sets.

PURE TONE

The reproduction of broadcasting by the "Minute Man" is remarkable for its clarity and sweetness of tone, increasing your enjoyment a hundredfold.

SIMPLICITY

The "Minute Man" is simplicity itself to operate. The dials can be adjusted by a child — and the set is "fool-proof." The dial settings are constant. A station once located can always be brought in without preliminary searching.

Free Booklet
Booklet "How to Build a 5-Tube Receiver, Using Three Phusiformers," sent free on request. Address Dept. 195.

Genuine mahogany cabinet and panels. Gold engraved dials.

PATHÉ PHONOGRAPH & RADIO CORP.
20 GRAND AVENUE :: BROOKLYN, N. Y.

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At Last!

SUPER-HETERODYNE

You can build it yourself

THE LAST WORD IN RADIO RECEPTION

Build this 8-tube set DeLuxe with our kit of guaranteed knock-down parts. Our kit includes all the necessary parts, together with loop aerial, panel, cabinet (8" x 40") and complete working plan and diagram. If you are interested in *selectivity, volume, clearness, long distance;* and if you want to *save money,* take advantage of this offer. *Send stamp for bulletin.*

PRICE COMPLETE $125 *f.o.b. Newark, N. J.*

THIS PRICE DOES NOT INCLUDE TUBES OR BATTERIES

NEW JERSEY RADIO SUPPLY CO.

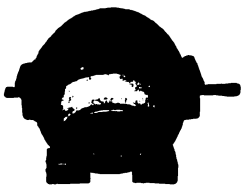
76 SPRINGFIELD AVE. Dept. A. NEWARK, N. J.

GET DISTANCE

USE THE FAMOUS

R. P. C.

NON— MICROPHONIC

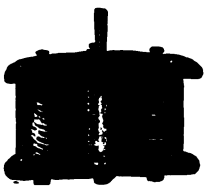


Moulded Bakelite VARIOMETER $5.00

Scientifically accurate for long distance tuning. Moulded of Mahoganite Bakelite.

"Guaranteed to Satisfy"

Dealers—Write for Attractive Proposition



23-Plate CONDENSER $1.50

Affords precise calibration at all wave lengths. Mechanically rugged, Electrically correct.

RADIO PRODUCTS CO.

Westport, Conn. U. S. A.

NOTHING IS WORTH WHILE UNLESS IT IS "RELIABLE"

Tune In On The Station You Want With Dependable Results

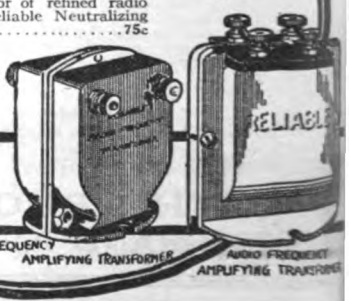
Are you master of your radio set or do you simply trust to luck in getting distant stations? You can get both distance and volume with

RELIABLE AUDIO and RADIO FREQUENCY TRANSFORMERS

Three stages of Audio Transformers to select from.
2 to 1 and 4 to 1 ratios at.....$4.45
6 to 1 ratio at.....4.95
Radio types from 150 to 750 meter ranges.....2.75

As an added factor of refined radio receiving use Reliable Neutralizing Condensers, only.....75c

The RELIABLE PARTS MFG. CO.
2819 Prospect Ave.
Cleveland, O.



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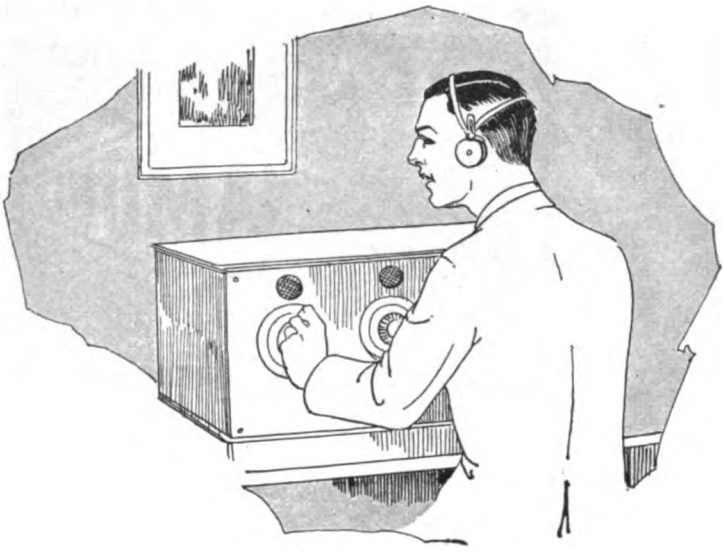


hours spent to solder connections carefully
. . . wires shortened
. . . circuits altered . . .

and still energy leaks away

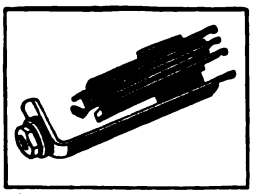
WHAT a tiny fraction of broadcasted energy actually gets to your set! How vital it is to prevent a particle of that energy from leaking away!

Yet in the most carefully constructed set, there are scores of places where stations you particularly want can literally leak away!

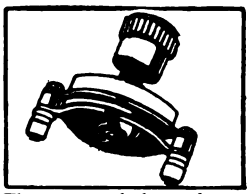
For *every small part* must convey current before energy *gets* to your phones or speaker. It's mighty important to you to know that every one of them is doing its full duty to prevent energy leaks.

MAR-CO small parts are made with precision, by the makers of scientific instruments — *designed* to stop leaks and conserve precious energy!

The compactness, the sure contacts hundreds of thousands have found in MAR-CO instruments, would be *worth* high prices. Actually, they save you money when you buy . . just as they save stations that might otherwise leak away—when you use them!



Eliminate short circuits with MAR-CO SHUR-GRIP jacks-Formica insulation, sterling silver contacts, hooked terminals for quick, leak-proof connections—60 cents to $1.00 and well worth it.



The compact, leak-proof construction, and the amazingly smooth, easy operation, of MAR-CO neutralizing condensers works wonders in R.F. circuits. Perfect neutralizing of tube capacity for $1.25.

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Night after Night—
They Continue to Serve
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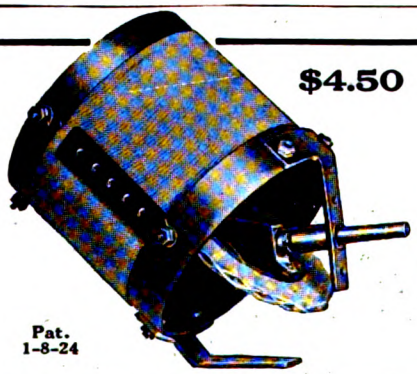

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NEW HARTMAN VARIOCOUPLER

with **180° Spider Web Wound Rotor. Small compact size saves panel space. Clearer reception with minimum coupling insured. Dead shaft has no capacity effect in tuning. Pig tailed contacts; no live brackets.**

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"The Best Built Set in America" R-212

RADIO SERVICE LABORATORIES

Licensed by I. R. M., Inc., under Hazeltine Patents

Embodying the Hazeltine Neutrodyne circuit in an improved form as to neutralization, workmanship, quality, appearance and efficiency of operation.

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The Transformer *is the* Heart *of* Your Set

THIS AUDIO FREQUENCY TRANSFORMER, by actual use and scientific test, has proved its reliability and dependability beyond question. In three-stage tests it has obtained perfect results, giving full tonal value of any instrument or voice from the bass viol to the piccolo and the deepest bass voice to the highest soprano.

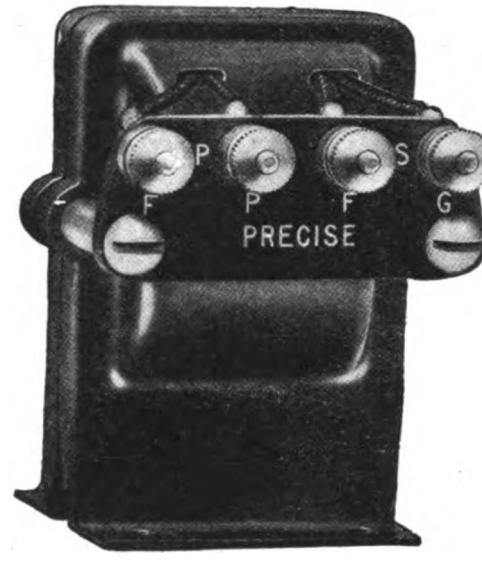
THIRTY DAYS' TRIAL

The Precise Transformer is so superior that you owe it to yourself to insist upon having it. If your dealer cannot supply you, order one direct. Purchase price refunded if thirty days' trial fails to prove every claim we make.

Attractive Proposition for Jobbers and Dealers

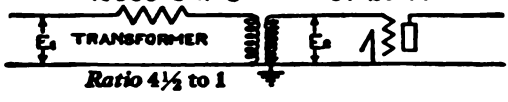
This unexcelled Transformer only $5

RATIO 4½ to 1

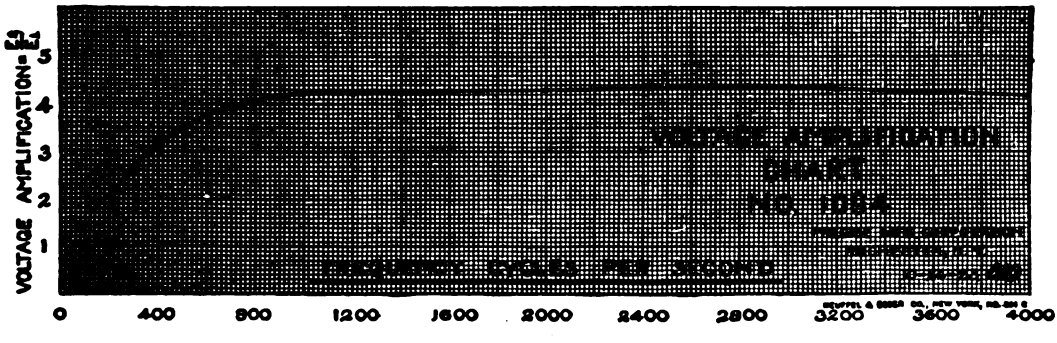


TEST OF PRECISE TRANSFORMERS

MODEL NO. 285A



This chart has been plotted showing the results of tests made in one of the best equipped laboratories in the country. These results are of vital interest to radio engineers and discriminating users of radio apparatus.



PRECISE MANUFACTURING CORPORATION

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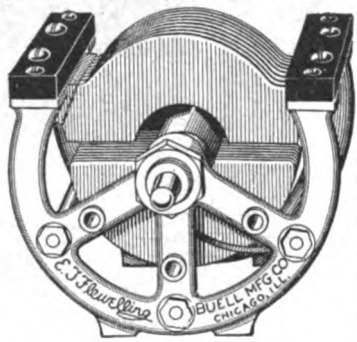
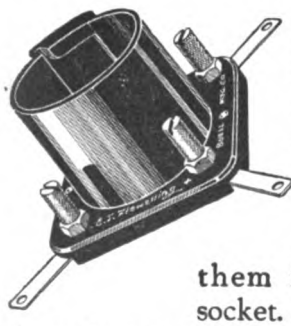
Genuine- E.J. Flewelling Radio Apparatus De Luxe



A new condenser, built in a new manner — and a better manner. Since its appearance on the market it has met with popular favor everywhere. You will be pleased with the extra high grade performance of such an instrument. At your dealers —or direct.

Flewelling Sockets are of efficiency— *second to none.* Short direct contacts of the improved *side-wiping* design make assured contacts with the tube terminals — that is why we use them in this superior socket. Ask your dealer to show them to you or write us direct.



Sockets—Tuners—Condensers

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2979 Cottage Grove Avenue
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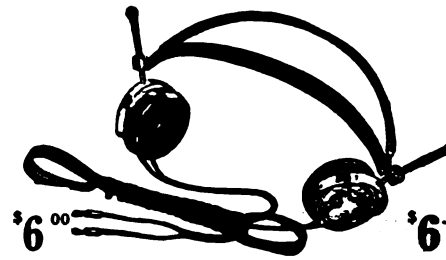
AMPL-TONE PHONES



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LOUD SPEAKER UNIT FOR HOME MADE SPEAKER
FREE
With Pair of Phones
Money Back Guarantee
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Branston Kit

No. R-99

R-91 Branston Intermediate Radio Frequency Transformer.

R-90 Branston Oscillator Coupler

Contains 1 Oscillator Coupler, complete with mounting brackets, bank wound inductance and adjustable coupling coil with locking device; 3 Intermediate Radio Frequency Transformers. Very sharply tuned and completely shielded; 1 Special Transfer Coupler for first or last stage of Intermediate Frequency; and 1 Specially designed Coupler for using Antenna. **$36.50**

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This apparatus is of standard Branston Quality, rigorously tested and proved better than anything heretofore obtainable. Its efficiency and superior performance will delight you.

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($1.00.) The amateur can easily make complete and efficient Super Heterodyne Receiver that will be extremely selective, give remarkably fine quality of tone and be noticeably free from interference.

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Every fan who wants a better set — will send for this booklet!

THE first edition of this brochure pointed the way to amazing results for thousands of set builders.

It enabled Mr. J. Tuckerman, President of the Federal Engineering Co., to build a set of which he says, "We not only get the local stations with remarkable clearness and absolutely without distortion, but we are able at any time to tune out these stations and receive from far away stations with equal facility. The tuning is so extremely selective and sharp that we can truthfully say we have never before listened with more pleasure and enjoyment to radio broadcasting."

Another typical report comes from Mr. G. V. H. Cairns of the Oakland Motor Car Co., who says, "I have tried all R. F. transformers on the market, but none of them can compare with Telos for volume, clarity, ease of operation, and best of all—they bring in the DX station!"

The second edition is now ready—packed with new ideas, proven hook-ups, and simplified instructions. It explains the Telos principle of tuned R. F. in complete detail. It gives you an entirely new viewpoint toward the possibilities of tuned radio frequency. Send for your copy. Write or use the coupon below.

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Send me a FREE copy of "Success with R. F. Amplification" and complete description of the Telos principle.

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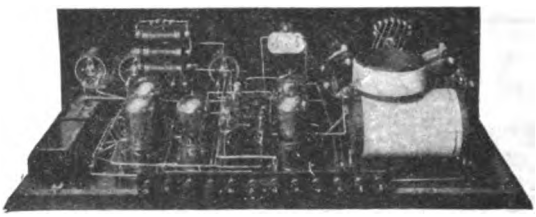
(By Courtesy "Popular Radio")



with COCKADAY IMPROVED 4-CIRCUIT KIT

Build Your Set

The "Amplex Kit Way"

SAVE 1/3

KIT FOR THE SUPERDYNE

A 4 Tube circuit that is taking the country by storm employing 1 step tuned R. F., combined with regeneration.

Includes everything from the bus bar to the drilled Panel and an exceptionally efficient special Coil and Coupler.

List, $45.00—Kit Price, $33.75.

DISTORTIONLESS AMPLIFIER KITS

2 TUBE:—Using one step of Transformer and one step Variable Resistance Coupling.

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4 TUBE:—Above with 1 Step Como Push Pull Amplification.

Kit Price, $35.00

48,000 Ohm Genuine "Lavite" Resistances, each $1.25

FREE *Send for Kit catalog showing how to build your set the "Amplex Kit Way."*

HERE IS PROOF

Dear Sirs: On the night of March 14th, during the Trans-Atlantic Test, I distinctly heard 2LO (London) on the set built with your 5 Tube Kit. At 6:27 P.M. I heard almost the entire selection called "Arcadia" played by a string orchestra. It all came in on a *Loud Speaker.* *M. Kramer, 2100 Davidson Ave., New York*

(This was subsequently verified by newspaper reports.)

Gentlemen: The first night I had my set in operation I heard KGO (Oakland, Calif.), to say nothing of 25 other stations.

I never constructed a radio set in my life before I bought your 5 Tube Kit and certainly agree with you that no technical skill or knowledge is required the "Amplex Kit Way." *D. P. Ecker, 1565 East 12th St., Brooklyn, N. Y.*

	List Price	Kit Price
1 Tube Cockaday Kit	$31.50	$24.75
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Parts	List Price Each
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2—Amplex 24 Pl. Vern. Cond.	5.00
5—Amplex Sockets	.75
1—6 Ohm Amplex Rheostat	.75
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2—Grid-Densers	1.25
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Parts	List Price Each
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12—Binding Posts	.10
Bus bar, etc.	.50

"Amplex" Grid-Denser $1.25 Each

DRILLED PANEL AND COMPLETE BLUE PRINT INSTRUCTIONS

for wiring and assembling with each Kit. No special skill or technical knowledge required. Safe and Simple.

Every part in every Kit is tested, guaranteed. Individual parts may be purchased separately at list price.

AMPLEX INSTRUMENT LABORATORIES

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Dealers—Write for Terms

As You Gaze at the Stars—

The gentle calm of a bright starry night fills us with mystery. Little did we dream a while back that today, far and wide in the unknown, thousands of voices, hurled by electrical energy, are rushing at unheard of speed through space to all points of the compass.

A person here, a group there—in fact, in a million or more homes people are anxiously tuning in on their radios, groping in the air, hoping to catch the sound of a far-away station. Scarcely a sound, a slight turn, a faint noise, another adjustment and then clear and clearer comes voices, a quartet is singing; so clear and distinct comes the soft gentle melody that the listeners close their eyes, the singers seem to be in the very room with them.

If you desire clearer reception, greater volume and the elimination of howling and distortions, install Jefferson transformers in your set.

There's a Jefferson Transformer for every circuit

Write for amplification data and interesting descriptive literature.

Jefferson Electric Mfg. Co.

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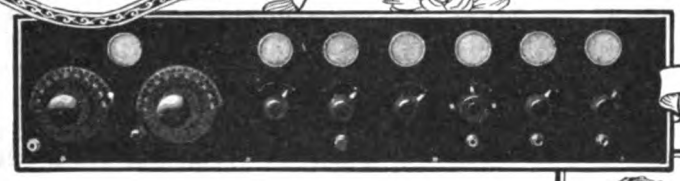
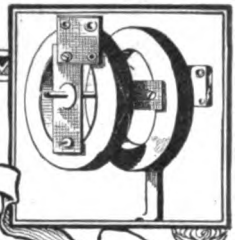
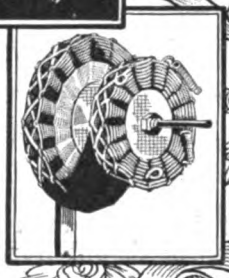
The Super-Heterodyne Made Easy for Everyone!







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Follow the *Manual* and your path will be easy. Results undreamed of will become commonplace in your radio enjoyment.

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Written by Victor Greiff, giving the fullest details and explanations on theory and practice. Includes three full size blue prints for panels, drilling, circuit, etc. The only complete and authoritative text book on the subject.

Transformer, Type 1716 ..... $8.50
Used in the Intermediate Frequency Amplifier. Covers frequencies from 5,000 to 25,000 meters. Self shielding. Steel core guarantees power and stability.

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Audio, specially developed for the circuit.

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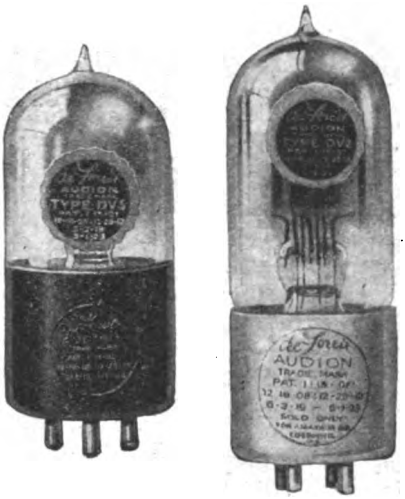

DV-3
Audion for Dry Batteries

DV-2
Audion for Storage Batteries

DE FOREST Audions are of especial interest to radio enthusiasts because it was Dr. De Forest who originally invented the three electrode vacuum tube which makes present-day radio possible.

The DV-3 Audion for dry batteries is designed to consume a very small amount of filament power. It operates at a filament potential of three volts and consumes a filament current of six-one hundredths of an ampere.

The DV-3 has a Yttrium filament, giving an unusually high flow of electrons; Bakelite base of standard dimensions; is remarkably free from microphonic noises.

The DV-2 Storage Battery Audion was developed for operation in all usual circuits, including a power amplifier circuit.

The DV-2 is a hard tube with Isolantite base and Yttriated filament and it is a particularly powerful tube for power amplifier work.

The price of these audions is $6.50, plus 6 per cent. for territories west of the Rockies.

All De Forest tubes are subject to three progressive inspections, all of them being burned for several hours and tested carefully.

The De Forest Company guarantees its products and backs this guarantee by a liberal replacement policy sufficient to cover all defects. Send for circular on De Forest Audions.

De Forest Radio Tel. & Tel. Company
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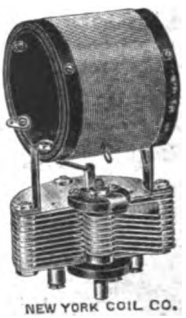
Jersey City, N. J.

De Forest Audions

"Made By The Man Who Invented Broadcasting."

TYPE 4

Trans= Former



NEW YORK Condenser Tuned Radio Frequency Trans-Formers are designed to operate in ***popular present-day circuits.*** Electrical losses, such as distributed capacity, have been reduced to the minimum.

The transformer is rigidly secured to our universally known New York Variable Condenser of 17 plates, which will tune sharply all wave lengths from 250 to 575 meters.

Price, including Condenser, $4.50

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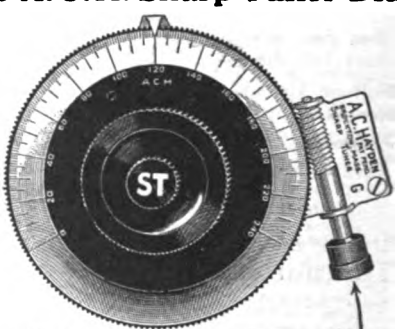
A Pleasant Surprise Awaits the User of the A.C.H. Sharp Tuner Dials



Why the A.C.H. is different

3 in. DIAL → ACH → 156-TO-1

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Will improve any receiving set, making difficult tuning easy

Money Back Guarantee

Price 3-inch size.... **$2.50** Price 4-inch size.... **$3.00**
Regular fitting 5/16 shaft ¼ and 3/16..... **5c** each extra

Extra Advantage of the A C H

1. Can be attached or removed from any instrument.
2. Rough tuning same as any dial.
3. Movement so fine that the eye cannot detect but the ear can.
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A. C. HAYDEN RADIO & RESEARCH CO.
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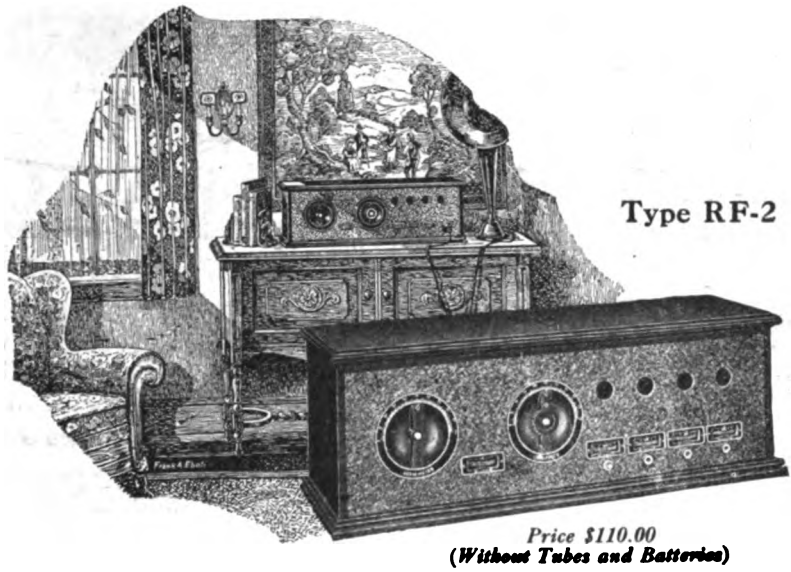

Type RF-2

Price $110.00
(Without Tubes and Batteries)

Pride of Possession—

Ownership of the new Eisemann Broadcast Receiver imparts a sense of keen satisfaction.

Little is left to be desired—not simply because of distinctive appearance, but by reason of the remarkable performance of the RF-2.

New distance records have been reported almost daily since the introduction of this latest receiver.

A transformer—coupled tuned radio frequency circuit is employed, with two stages of audio frequency amplification.

ASK YOUR DEALER

Descriptive Literature on Request

EISEMANN MAGNETO CORPORATION
William N. Shaw, President
46 Thirty-Third Street Brooklyn, N. Y.

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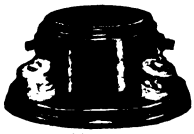
Na-ald No. 499

Na-ald Small Space
No. 401

Cross Section
De Luxe Socket

Na-ald No. 411

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No. 400

NA-ALD

IT'S THE CONTACT THAT COUNTS

Na-ald Sockets

For 200 Tubes
No. 400, Price 75c
No. 401, " 35c
3 for $1.00

For U. V. 199
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No. 411, Price 75c

The best radio engineering practice of today calls for the elimination of as much material as possible in the neighborhood of those parts of the set which carry the radio frequency current. This applies not only to metallic substances, but to insulating materials as well.

Na-ald Sockets provide for this by having uniform walls of Bakelite, giving the material its highest di-electric properties.

"Frying" noises, often attributed to B batteries, are in reality caused by poor connection. Na-ald De Luxe contacts not only press on the bottom of tube terminals but cut into the sides, automatically making a bright, perfect connection. *De Luxe is the standard for Neutrodyne and Superheterodyne sets.*

Send cover of Na-ald dial or socket carton or 15c for new 16-page rotogravure booklet "What to Build."

ALDEN MANUFACTURING CO.
Dept. C. 52 Willow St., Springfield Mass.

"I would not use any other battery after KIC-O"

says Frank W. Harris, a radio fan of Ottawa, Canada. KIC-O Storage "B" Batteries will improve any radio set. Try one on yours. Our guarantee protects you. The life is unlimited. Recharge from any 110 volt A.C. line with small home rectifier.

Volts	Price, plain	With panels
22	$5.50	
32	7.25	$11.75
48	9.50	14.00
68	12.50	17.00
100	17.50	22.50
145	23.50	28.50

Unmounted Rectifier.. $1.00
Mounted Rectifier.... $2.50

GUARANTEE

Your money back on any KIC-O Battery if not satisfied within 30 days' trial. Write for full information on "A" and "B" Batteries.

KIC-O Storage "B" Batteries Long Service, Low Cost

KIMLEY ELECTRIC COMPANY, Inc.
2667 MAIN STREET, BUFFALO, N. Y.

STORAGE "B" BATTERIES KIC-O

COCKADAY COILS

Improved type, silk covered wire, bakelite tube, complete $4.00

Regular coils, cotton covered wire $2.50

Complete parts for single tube set $10.95

All parts for improved five tube set $55.00

Shipped C. O. D.

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HELENA, MONTANA

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Genuine LAVITE RESISTANCES

12,000 OHMS
48,000 "
50,000 "
100,000 "
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Money Orders and Checks Only
NO STAMPS
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65¢

THE BRADY LEAK

Although it is cartridge type it is different in principle from any Variable Grid Leak you have ever used before.

COMPLETE WITH MICA CONDENSER AND PERFECT LEAK MOUNTING $1.00

At your dealer—or postpaid on receipt of purchase price.

A.C.BRADY CO.

Improved Radio Apparatus

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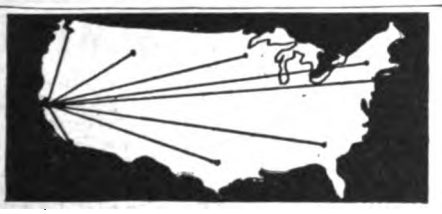

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Broadcasting from Atlantic Coast, Canada, Mexico, Cuba & Hawaii heard in Calif. by users of the CROSS COUNTRY CIRCUIT. Range due to simplicity. One tuning control. ANY NOVICE can build easily and cheaply. Dry cell tubes used. No soldering. Complete instructions, Blue print panel layout, Assembly Photo, etc., postpaid 25 cents. Stamps accepted.

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UNITY VERNIER RHEOSTAT

The Highest Type Instrument Made

Any Resistance $2.00

"Hear a Set That Uses One"

ELIMINATE THE NOISES IN YOUR SET

The book "TUBE CONTROL," written for the amateur, and for the benefit of Radio Reception, by J. Elliott Jenkins, Engineer of Broadcasting Station W. D. A. P. will tell you how to clear up your signals.

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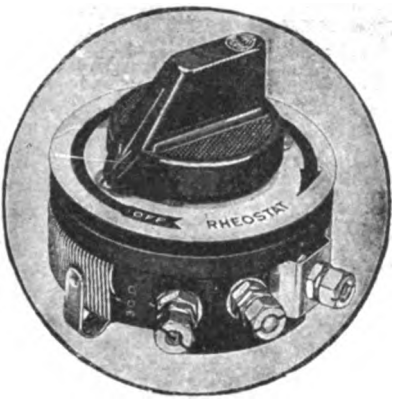

The Pacent RHEOSTAT *a Favorite*

The merit in the Pacent Rheostat is evidenced in its choice by leading radio authorities and its selection as standard equipment by leading set manufacturers.

It is ideal, considered from standpoints of design, operation and attractiveness of appearance. Construction in only two units simplifies installation. Fastening a single set screw insures against parts loosening or knob turning beyond its range. The Rheostat is supplied entirely complete with screws for mounting, knob and silvered dial.

Pacent Rheostats are made in a number of resistances for various needs.

Cat. No.	Resistance	Capacity Amperes	Price
85-A	6 Ohms	1.5	1.00
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85-E	50 Ohms	.3	1.00
85-F	2½ Ohms	2.5	1.20
88	375 Ohms	.2	1.25

Write for Catalog P-5

Pacent Electric Co., Inc.

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Established 1909

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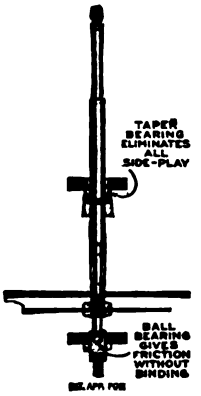
For Sturdiness and Accuracy Use Lombardi Condensers



Made in the most popular sizes, with aluminum plates, aluminum end brackets, with a ¼" diameter insulating bushing therein. (A perfect insulator, high in dielectric strength.)
The tension as well as adjusting is accomplished by tightening end thrust plug, which has a spring plunger, causing a thrust of proper tension between a hardened steel ball and a 45 degree tapered brass bushing, this insures smooth running and a contact equal to a soldered joint; also a take up for wear in years to come.

Also makers of coils and sockets

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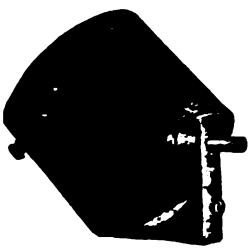

180° Vario-Coupler
With a Special Woven Rotor

will bring in those distant stations you are trying for. An exceedingly efficient and neat coupling device combining all of the best features that have been developed in the past year and which will cover all broadcast wave lengths up to 600 meters.

Price - - $3.50

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A NEW 5 Tube

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Selective — Sensitive
Non-Radiating — Single Control

THE peak of Mu-Rad skill and ingenuity. Coast to coast reception under proper conditions. Loud speaker reception on a thousand mile range, all wavelengths. Completely cuts out the strongest local stations. Surprisingly simple control—just one dial, the settings of which are *always* the same for each station, regardless of your location or type of aerial. Requires only a single wire antenna. Uses either dry cell or storage battery tubes. Tubes and batteries last twice as long as in other 5 tube receivers, because the new circuit used permits burning tubes at low temperatures. Like other Mu-Rad Receivers the MA-18 towers above competition and imitation.

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SPECIFICATIONS

Circuit 2 stages of R. F. Amplification, detector and 2 stages A. F. Amplification —an entirely new circuit.

Antenna—single wire—20 feet to 150 feet long.

Cabinet Hand rubbed solid mahogany with rubber feet. 12¾ inches by 7½ inches by 15 inches deep. Engraved Formica Panel.

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PRICE (without accessories) **$110**

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If so it will pay you to consider

THE COPP VARIO-SELECTOR

Patent Applied For
Copp Vario-selector
Price $11.50

Because:

1. It will CHANGE any single circuit set to a double circuit set without re-wiring and without rebuilding. Simply connects to Antenna and ground and it is done.
2. ELIMINATES RE-RADIATION. This will be a great help to Broadcast Stations and to all owners of Broadcast Receiving Sets.
3. GIVES SELECTIVITY to a Single Circuit Set equal to any three-circuit tuner, preserving the Single Circuit simplicity of tuning.

NOTE.—The Copp Vario-Selector is NOT a Wave-Trap.

No necessity for the single circuit set owner to discard his set because of its lack of selective quality. No need to worry about disturbing the neighborhood with re-radiation. The Copp Vario-Selector will correct all these faults the minute it is added to the set.

Sold thru your dealer or direct.

If your dealer cannot supply you with a Vario-Selector, mail the coupon direct to us today.

The A-C Electrical Mfg. Co.
Dayton, Ohio

Gentlemen:

Being unable to secure a Copp Vario-Selector from my dealer, you may send me { check enclosed / C.O.D. parcel post } { one Copp Vario-Selector, it being understood that in case I am not entirely satisfied with its operation in connection with my set, I reserve the right to return the Vario-Selector to your factory (in same condition as received by me) any time within ten days, full purchase price to be returned to me at once without further question.

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Standardize NOW on PREMIER PARTS

"The Better the Set the More You Get"

½ Actual Size

$3.50

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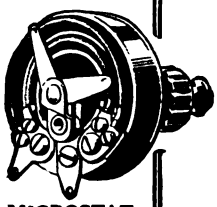
Trade Mark

The wonder of the Radio world. A more efficient transformer than you could ever buy before. And the smallest, most compact instrument of its kind. About the size of an English walnut and yet **"HEGEHOG"** is a wizard for reproduction value, tone quality and consistent performance. Less distortion. No foreign noises. The secret is in its patented construction. **It is shielded 100 per cent.** Fully guaranteed. Ratios 1 to 3, 1 to 4, 1 to 5, $3.50; 1 to 10, $4.50. You'll want **"HEGEHOG"** in your next "hook-up," so get all the facts **NOW.**



MICROSTAT

$3.00

PREMIER "MICROSTAT" A Super-Vernier Rheostat

Trade Mark

"MICROSTAT" is in a class by itself as a precision instrument for the perfect control of the filament current in detector tubes, and everyone knows that you must control this current to the finest degree if you are going to get the ultimate from any set—**"MICROSTAT"** does all this. Built on an entirely new principle. Two windings in parallel—one 6 ohm—other 40 ohm. Absolutely noiseless—infinite control—handles any tube. Capacity 3 Ampere Bakelite moulded—silver etched dial. Do not install a Rheostat until you know all about the **"MICROSTAT."** Send for our Free Bulletin No. 92.

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19 Years Making Quality Electric Apparatus

30 STATIONS in one hour!

—heard with one Myers Tube (name and address furnished on request). The remarkable results being obtained with Myers Tubes are due largely to the elimination of socket with its bunched leads.

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Myers Tubes

(practically unbreakable) give you distance with clarity. They add 50% to the efficiency of any set by reducing interference.

See that you get the New Improved Myers. Others are not guaranteed. Insist on Myers at your dealers'—otherwise send purchase price and be supplied postpaid.

Two types: Dry Battery and Universal (for storage battery). Write for free circuit diagrams.

$5 EACH, complete with clips ready to mount on your set; no sockets or other equipment necessary.

E. B. Myers Co. Ltd.
Radio Vacuum Tubes

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Guaranteed Head-Sets

"RED-HEADS" are *guaranteed* radio phones. You run no risk when you buy them. Money back if, after 7 days' trial, you're not satisfied that they're the *best* receivers on the market at the price. Why not act *right now* and get a pair? It'll mean getting the *maximum* from broadcasting from the day you put them into use.

RED-HEAD RADIO RECEIVERS

NOW READY

The new 1924 Model F **$6.50** Per Pair Complete

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"Red-Heads" sent prepaid on receipt of price if you are unable to get them at your dealer's.

The NEWMAN-STERN COMPANY
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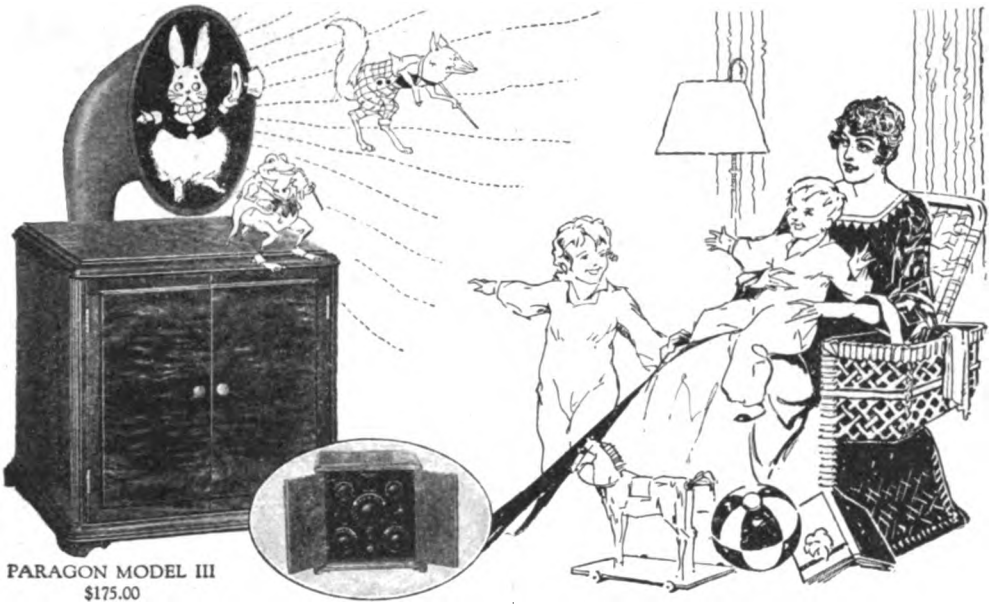

PARAGON MODEL III
$175.00

"IT WAS PETER RABBIT—"

"- - - and all dressed up in his new suit to go on the journey with Reddy Fox", comes the voice over the radio. The children sit spellbound. Mother, thankful for this few minutes' rest every evening, closes her eyes and leans back in her chair. Now the radio will take care of the children—she needn't worry.

Paragon Receivers are rich in tone value. Music, from the crash of a chord to the sob of a saxaphone, is reproduced clearly just as it is played. Voices are distinct and understandable. Static noises are reduced to the absolute minimum.

Because of Paragon selectivity and sensitivity you can tune in on and get any station you want, and hear the program without interruption or jamming from other stations.

The Paragon Model III comes in a finely finished mahogany or burled walnut cabinet which is an addition to any home. This instrument offers you the ultimate in radio enjoyment.

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PARAGON

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3-CIRCUIT RECEIVER

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Every Question ANSWERED for only $1

At last you have under one cover a Complete Radio Handbook

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514 PAGES

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TUNED RADIO FREQUENCY
VARIOTRANSFORMERS

TYPE VT25 LIST $8.50

Connected same as a fixed radio-frequency transformer, but continuously adjustable to the peak of the wave.

MAXIMUM AMPLIFICATION AT ALL WAVE LENGTHS

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Metalectric Soldering Iron

Operates on any electric current with the simplicity, ease and efficiency of a writing instrument.

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Accepted as the logical solution to radio soldering problems.

NOW ONLY $3.75

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Interchangeable Tips
Handle always cool

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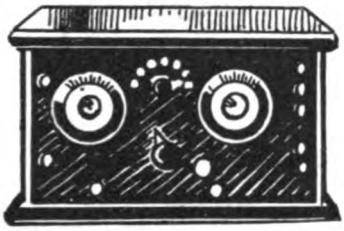
Learn at Home To be a Radio Expert



The amazing expansion of Radio has opened thousands of wonderful new opportunities. Big salaries, easy and fascinating work, short hours and an excellent future are offered to ambitious men who enter the Radio field now.

Free 1000 Mile Radio Outfit

This set, when erected, has a range of over 1,000 miles. The cabinet is elegantly finished in a beautiful, lustrous mahogany. You can sell it at a handsome profit if you care to, after you have completed my course. Remember, you do not pay a single penny for it.

Membership Is Valuable!

Upon completion of my course, you receive a membership in the Radio Association of America. This designates that you are a thoroughly trained Radio man. It gives you prestige and a standing in your community not otherwise possible.

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My course enables you to construct, install, operate, repair and sell Radio equipment. As my representative, you can, using either your full time or spare time, take orders from your friends and neighbors. You can easily earn from $35.00 to $125.00 a week installing Radio sets in your locality. It is being done every day by my students. What others have done, you can do.

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PROOF

Dear Mr. Mohaupt:
Your lessons are very easily digestible. To say that I enjoy them would be putting it very mildly—indeed, I crave them.
And, about the job at the Operadio Corporation; yes, I got it, thanks to you. I am learning to be an inspector at present, but I'll not stop there.
Please send me additional lessons as soon as possible.
GEO. A. GRAESSLE.

A. G. MOHAUPT, Radio Engineer

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Radio Experts Earn $3,000 to $10,000 a Year

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My course is not "high-brow." It is written in plain, everyday language that can be understood by any man. You need have no previous training or experience. I give you a receiving set so that I can take you thru the various steps of Radio work in a practical way. You will be delightfully astonished in having made clear to you the wonderful forces of Radio that appear so mysterious to the untrained person.

FREE I have ready for you a copy of "Radio Facts" which tells you of the latest opportunities that exist in the great field of Radio. I want you to note my "Money Back" guarantee that protects you absolutely. I also want to tell you about the big free 1,000 mile Radio Tube Set that I give away free with my course. I urge you to act at once. Fill in your name and address on the coupon and mail it to me immediately

MAIL COUPON

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4513 Ravenswood Ave., Dept. 55A, Chicago, Ill.

Please send me details of your Home Study Course—also your Free "Radio Facts" and information on how I can get a FREE 1,000 mile Radio Set.

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For High Oscillating Radio Frequency Circuits

Note carefully these eleven important features

1. Lowest Dielectric Losses
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9. With or without 9 plate Vernier
10. 9 plate Vernier makes possible sharp, close tuning
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Made With Vernier in 45-23 Plate Type and in 45-23-17 and 11 Plate Type Without Vernier

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At your dealers, otherwise send purchase price and you will be supplied postpaid.

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No Two Receivers Are Alike

Connect In Multiple and One Will Get Most Current

AJAX—MULTI—RADIO

Phone Plugs and Connectors
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PERFECT for every CIRCUIT
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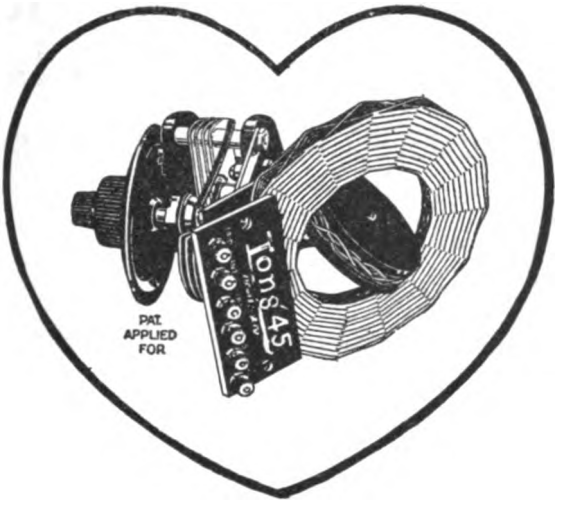

COAST TO COAST

"Long 45"

REGISTERED

is the one tube sensation of the radio world. Letters are pouring in telling of its wonderful effectiveness at little cost. The New York and Chicago newspapers are fully covering the interesting news features regarding the "Long 45" tuner which is the heart of the new Long 45 set. Read what the papers are saying. See it at your dealers. Or write us for particulars.

MARCO MEYER & CO.

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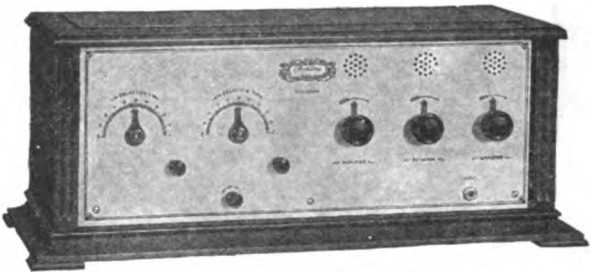
Announcing the New Goldcrest Clearodyne Models

Model 70



$75.00

Cleartone engineers have perfected a new circuit, embodying the desirable features of SELECTIVITY-LOG-ABILITY, EXTREMELY SIMPLE TUNING AND PERFECT CONTROL in the new GOLDCREST CLEAR-O-DYNE FOUR TUBE MODELS.

The beautifully etched, gold-finished panels and the distinctive, solid mahogany cabinets combine to give you a receiving set which is a valuable addition to any home, and a source of amusement, education and great pleasure for the entire family.

Long distance records are being established with these new models on which testimonials are being received daily. We want you to see and be convinced. Write today for free illustrated circulars, showing all of our beautiful cabinet models.

DEALERS and *JOBBERS:* Look at the prices below—then at the distinctive design and characteristics above. Write for our interesting proposition—a business builder.

Model 60	$60.00	Clear-O-Dyne Model 70	$75.00
Model 61	75.00	Clear-O-Dyne Model 71	90.00
Model 62	120.00	Clear-O-Dyne Model 72	135.00

The Cleartone Radio Company, Cincinnati, Ohio

The TWITCHELL AUXILIARY TUNER

PATENTS PENDING — **NAME REGISTERED**

More Than a Wave Trap

A TWITCHELL AUXILIARY TUNER connected to any make of tube receiving set will positively cut out any local broadcasting or code stations so you may tune in all long distance stations any time regardless of local conditions.

Unlike any wave trap, THE TWITCHELL AUXILIARY TUNER does not ever decrease but in many cases increases the volume from distant stations.

These TUNERS are in daily use within 400 feet of large broadcasting stations and enable their owners to easily and completely cut out the local station and bring in distant stations at any time on a loud speaker.

This instrument will also enable you to bring in programs sent out on longer waves than you can tune in without it, thus bringing all the broadcasting stations within the wave length range of the many sets of limited range now in use.

Copyrighted diagram of this tuner, 50c, or with all parts, $9.00
Complete instrument in walnut cabinet, ready to use, $15.00

A New and Wonderfully Efficient Coil, for the Reinartz circuit for those who want **the best. Price, $4.00,** or with blueprint for either one or three tubes, **$4.50.**

This circuit brings in both coasts loud and clear and is the most successful Reinartz modification yet produced.

All goods prepaid. These instruments are easy to build, easy to operate. Everything clearly shown

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Let This Amazing RADIO Book Answer Your Questions

106 Pages—260 Radio Questions and Answers—92 Illustrations—Radio Terms, Laws, Regulations, Symbols and Equations. List of Latest Broadcasting Stations—Explanations of All Types Receiving and Transmitting Sets. Over 10,000 sold—NOW ONLY $1.00! Send Money Order, check or cash. (Guaranteed to satisfy or money refunded.) None sent C. O. D.

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$15

have a tone-quality unapproached by metal, natural wood or any other material. Equipped with special loudspeaker unit of great power.

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A Leather Covered Radio Set

Because—Experts found that *leather* is the only material that will withstand wear and hard usage.

Because—it reflects quality.

Because—it costs no more than imitations.

We are manufacturers of all grades of cowhide grains.

Manufacturers—You will need leather for PORTABLE SETS. Write us for free samples and full information.

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GRID-DENSER

IMPROVES ANY CIRCUIT

$1.25

Specified by L. M. COCKADAY and other prominent engineers

Variable Condenser 0 To .0005 Mfd.

Absolutely Essential in

COCKADAY, SUPER-HETERODYNE, NEUTRODYNE, ULTRADYNE, SUPERDYNE and All Sensitive Circuits for 100% results.

Every tube and every circuit requires a different fixed capacity. Good or poor results depend upon its exactness. A slight turn of the GRID-DENSER knob finds it for you and permits operation of set at highest point of regeneration, controls oscillations and maintains perfect stability, giving *GREATER Distance and Louder and Clearer signals.*

FREE Booklet with hook-ups showing how to double the efficiency of your set.

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KING OF ALL

Tune in those distant stations with a pair of "Royalfones."

JACK BINNS, says, "They will give an audible sound with a weaker signal than the average phone."

That is why you will get distance where you don't with your present pair.

If your dealer can't supply you, write direct.

Royal Electrical Laboratories
Dept P. R., Newark, N. J.

Royalfone
KING OF ALL

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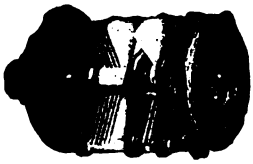
CHELSEA

SHARPER TUNING
AND
MORE VOLUME
with CHELSEA parts

No. 75 Radio Frequency Tuner



The proper amount of inductance and capacity to most efficiently tune between stages of a tuned radio frequency amplifier with minimum controls.

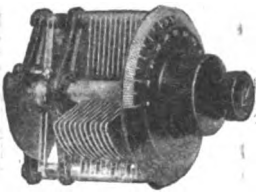
Wave length, all broadcast waves; price with dial and Vernier $5.75

No. 70 Antenna Tuning Unit

Combining the correct amount of inductance and capacity for most efficient tuning of antenna circuit, inductance with four taps.

Wave length, all broadcast waves; price with dial and Vernier $5.75

Variable Condensers



Low Loss

Genuine bakelite insulation. Pigtail connection to rotor Absolutely Guaranteed.

#10—23 plate with Vernier $4.50

Amplifying Transformers

Genuine bakelite insulation. Highest grade silicon steel core. Tested to 500 volts. Easy to assemble in your set. Ratio 3¾ to 1.

Price $4.50

Chelsea offers a complete line of parts and sets

At your dealers or write direct

CHELSEA RADIO COMPANY
183 SPRUCE STREET
Chelsea, Mass.

LISTEN-IN RADIO RECORD
REGISTERED U.S. PAT. OFF.

THE ONLY "LISTEN-IN" BOOK

KEEP A RECORD OF STATIONS HEARD, DIAL SETTINGS, RECEIVING CONDITIONS, ETC.

Flexible cloth binding. Gold stamping. 160 pages. Printed on Bond Paper. Contains introductory article "How to Receive Radio Broadcast," by Lloyd C. Greene, Radio editor Boston *Globe*. Many Radio Hints and Tips. Complete list of Broadcasting Stations and double page map of United States.

PRICE **75 cents**

At Your Dealers or Sent Prepaid on Receipt of Price

LISTEN-IN PUBLISHING CO.
110 MAIN ST.
CAMBRIDGE, MASS.

2 Transformers for the price of 1

NEUTRODYNE

No Distortion
Greater Volume
Half-Price

For $6 we will send postpaid TWO of the famous Globe Audio Transformers made especially for Neutrodyne sets.

MONEY BACK GUARANTEE

If you are not fully satisfied with the transformers, return them within 5 days and your money will be refunded.

COYNE RADIO SERVICE
Suite 603
507 Fifth Avenue, New York City

RADIO TUBE EXCHANGE

We Repair All Standard Makes of Tubes, Including

W.D. 11 or 12
U. V. 199 or C. 299
C. 11 or 12
U.V. 201A or C. 301A
D.V. 1 or D.V. 2
U.V. 200 or 201
C. 300 or 301

$2.50

All tubes guaranteed to do the work

RADIO TUBE EXCHANGE
200 BROADWAY, NEW YORK CITY, N. Y.
All Mail Orders Given Prompt Attention
Orders Sent Parcel Post C. O. D.

Supremacy Proven by Every Test

FIL-KO-STAT
THE SCIENTIFICALLY CORRECT RADIO RHEOSTAT

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WHOLESALE RADIO SERVICE COMPANY

9 Church St. N.Y.C.

IMPROVED 4 CIRCUIT TUNER

Complete Parts as Specified $53.50

This is the set that Cockaday described as being able to receive over distances of 3,000 miles. You can't build anything better! It uses five tubes.

(Complete with Push Pull Amplifier)

1 Cockaday Improved Bakelite Coil
2 Amsco 26 Plate Ver. Condensers
2 Amplex Gridensers
1 Bradleyleak
5 Melco Sockets
1 Amsco 6 ohm Rheo.
3 Amsco 20 ohm Rheos.
1 Pacent Single Jack
2 Pacent Dble. Jacks
2 Amertran Trans.
1 Como Push-Pull Input
1 Como Push-Pull Output
2 Switch Levers
11 Switch Points
2 Switch Stops
1 Dubilier Cond. .0005
1 Dubilier Cond. .00025
1 Durham Var. Leak
3 Lavite Resistances, 48,000
1 Amsco 400 ohm Potentiometer
1 7 x 24 Panel
1 3 x 2¼ Sub-Panel
1 12 x 12 Panel
1 7 x 24 Baseboard
Blueprints, Wire, etc., with each order.

This is an outstanding bargain. Send for the parts at once for **$53.50**

COCKADAY 3 TUBE SET

The Cockaday 3 Tube Set (the original Four Circuit Tuner) is still a favorite with the DX fans. We have grouped the complete parts—everything needed to build the set,—for..... **$19.50**

YOU SAVE—

by buying from us. Our service enables you to buy for at least 20% less! And the shipments are made promptly.

We ship C. O. D. if you wish—or else you can make remittance by money order when ordering.

WRS NEUTRODYNE

A dandy 5-tube Neutrodyne that will bring in the long distance stations without squeals or howls. The parts are the very best.

1 7 x 26 Baseboard
3 Neutroformers
2 Neutrodons
5 Nat'l Bakelite Sockets
2 Jefferson Trans formers
2 Filament Control Jacks
1 Cut-Hammer Battery Switch
1 Bestone Power Rheo and Dial
1 30 ohm Bestone Rheo. and Dial
1 7 x 26 Drilled Panel
1 .00025 Dubilier Condenser
1 2 Meg. Leak
2 .006 Mica Condensers
8 Initialed Binding Posts
Spaghetti, Wire, Blueprint and Booklet.

The complete parts with DRILLED panel

$32.50

Other Bargains

A trial order will convince you that every purchase from Wholesale Radio Service is a bargain. Write for our wholesale prices on any part or set you may wish to get.

We Sell Retail At Wholesale Prices!

Full, rich, mellow tone. Absolutely no distortion. Beautiful in appearance. No extra batteries necessary.

FULLY GUARANTEED..... $7.50
(By Parcel Post, 15c. Extra)

Send for Complete Catalogue

STANDARD RADIO CO.
611 E. MARKET ST. PHILADELPHIA, PENN.

VACUUM TUBES REPAIRED

WD-11, WD12, UV-201A, UV-199, And others for $2.50

Quick service. All tubes repaired by us guaranteed to work as good as new.
Send your dead tubes. All you pay is $2.50 plus Postage to Postman.

THOMAS BROWN CO.
511-519 Orange St. Newark, N. J.

TWO of the three Philadelphia stations that tuned in London were equipped with "Turn-it" Adjustable Grid Leak—the perfect grid control

—Varies ½ to 5 megohms.
—No carbon or graphite.
—No sliding contacts.
—Eliminates microphone noises on DX Stations.

TURN-IT RADIO SALES, INC.
Sole Distributors for Charles E. Bonine
30 Church Street NEW YORK

At your dealer or direct upon receipt of price $1

TURN-IT ADJUSTABLE **GRID LEAK**

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Blueprints

"Improved" Cockaday 4-Circuit Tuner and Tuned-Radio-Frequency Receiver

SO great has been the demand for POPULAR RADIO's Blueprints of the "Improved" Cockaday 4-Circuit Tuner, that we have now prepared similar actual size Blueprints of the Non-Regenerative Tuned Radio-Frequency (neutrodyne) Receiver described last month.

EACH of these sets of Blueprints has been drafted by our own staff under Mr. Cockaday's personal supervision. They are full size, accurate, authoritative—and so simple to follow in all details that a novice can work from them without difficulty.

The two complete sets of **three** prints each, covering all constructional requirements for these two highly-efficient receivers, include an exact panel pattern, an actual size instrument layout, and a picture diagram of all parts **showing every wiring connection.**

With these actual size Blueprints you can drill your panel without taking a single measurement; you can arrange your instruments and parts in exactly their correct places without guess or hesitation—and you can connect all terminals without even knowing how to read a hook-up diagram.

To make these Blueprints available to all, they have been priced at the very low figure of only $1.10 postpaid for each complete set of three prints. The complete set of three prints on the "Improved" Cockaday 4-Circuit Tuner may be had at $1.10 postpaid. The complete set of three prints on the Non-Regenerative Tuned Radio-Frequency (neutrodyne) Receiver may also be had at the same price, $1.10 postpaid.

It will interest our readers to know that we have also prepared a set of Blueprints covering an Audio-frequency Amplifier that will not distort. A detailed description of this Amplifier will be found on page 476 of this issue. The complete set of three Blueprints will be sent on receipt of your remittance of $1.10.

We cannot break Blueprint sets to supply single prints. Any Blueprint set of three sheets will be sent by return mail on receipt of $1.10; any two sets for $2.20; all three sets for $3.30. For convenience use the coupons below.

POPULAR RADIO, INC.

627 West 43rd Street — Dept. 54 — New York City

POPULAR RADIO, Inc., Dept. 54
627 West 43rd Street, New York City

Enclosed is $1.10 payment in full for the set of three Blueprints checked.

☐ "Improved" Cockaday 4 Circuit Tuner.
☐ Non-Regenerative Tuned Radio Frequency Receiver.

(a) Exact panel pattern.
(b) Actual size instrument layout.
(c) Picture diagram of all parts (actual size) showing complete wiring.

Name.....

Address.....

.....

POPULAR RADIO, Inc., Dept. 54
627 West 43rd Street, New York City

Enclosed is $1.10 in full payment for a complete set of three Blueprints for the **Audio-frequency Amplifier** consisting of the following:

(a) Exact panel pattern.
(b) Actual size instrument layout.
(c) Picture diagram of all parts (actual size) showing complete wiring.

Name.....

Address.....

.....

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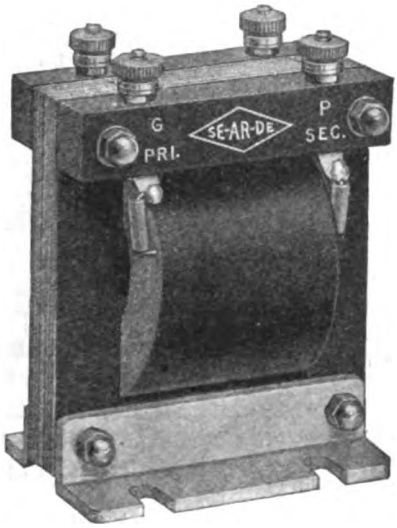
SE-AR-DE

QUALITY

HERE IS A WINNER



SE-AR-DE

Amplifying Transformer

Turn Ratio 4-1

20% louder signals with less distortion than any transformer on the market.

Large! But oh boy, you should send for copy of the amplification curve.

Price $5.00

R. MITCHELL CO.

255 Atlantic Ave. Boston, Mass.

EXPORT OFFICE

44 Whitehall Street New York

PACIFIC COAST OFFICE

Mission Street San Francisco, Cal.

Spintite Wrenches

MAKE THE HEX "BEHAVE"

That's exactly what this new tool does for you—makes the hex nut "behave!" Puts an end to fussing and mussing with pliers in cramped corners.

Held securely in the hexagon head of "Spintite," a hex nut can be screwed *tight*, no matter how confined the working space.

Hollow stem goes over projecting screw-end. Ebonized handle, built to fit the finger grip, spins hex on in a jiffy. Hooking up becomes a joy with the "Spintite." You'll get greater distance and volume.

Sizes $\frac{3}{16}$" to $\frac{3}{8}$", 35c each. Large phone jack sizes, $\frac{7}{16}$" to $\frac{1}{2}$", 65c each.

If your dealer can't supply you send his name and write to us direct

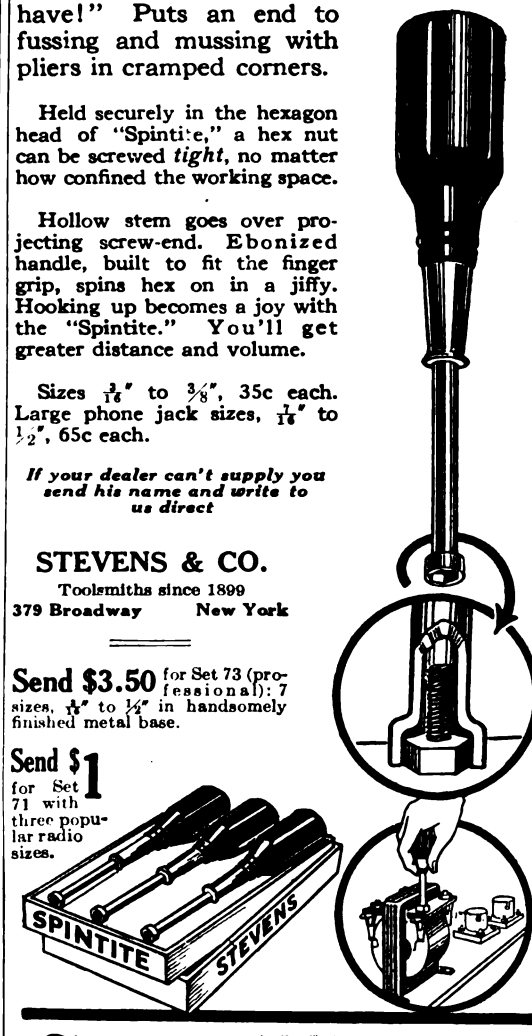
STEVENS & CO.

Toolsmiths since 1899

379 Broadway New York

Send $3.50 for Set 73 (professional): 7 sizes, $\frac{1}{16}$" to $\frac{1}{4}$" in handsomely finished metal base.

Send $1 for Set 71 with three popular radio sizes.



Stevens SPEED UP Tools

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MAHOGANITE Dials that match the set

Like all other distinctive products, Mahoganite has its imitators. But these imitations are on the surface only. Mahoganite is not a surface finish. The electrical values of Mahoganite extend through the material.

The only way to assure yourself of genuine Mahoganite Panels, or Dials which match the panel, is to make sure that the RADION Trademark is on every one that you buy.

21 Stock Sizes
Mahoganite and Black

6 x 7	7 x 14	8 x 26
6 x 10½	7 x 18	9 x 14
6 x 14	7 x 21	10 x 12
6 x 21	7 x 24	12 x 14
7 x 9	7 x 26	12 x 21
7 x 10	7 x 30	14 x 18
7 x 12	7 x 48	20 x 24

RADION

The Supreme Insulation

PANELS

Look for this stamp on every genuine RADION Panel. BEWARE of substitutes and imitations.

At good Radio Shops or write to

American Hard Rubber Co.
11 Mercer St. New York

RATHBUN

SINGLE-HOLE MOUNTING

SUPERIOR CONDENSERS

Special—13 Plate

NEUTRODYNE

CONDENSERS

Ordinary condensers will *not* do for the Hazeltine Neutrodyne circuit. A special 13-plate Rathbun Condenser is being widely used because it answers every demand of this circuit so perfectly. Plates are held in better alignment due to single hole mounting and anchoring of plates in accurately milled posts. Every bearing is true and hard wearing. Hence adjustment is always uniform. The success of your Neutrodyne Receiver is worth your insisting upon ***RATHBUN Condensers.***

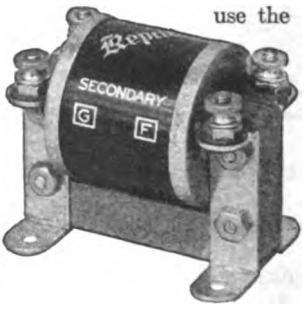
Capacity
.0003 MFD
LIST
$3.00

Write TODAY for the name of the nearest Rathbun dealer and for illustrated literature.

Rathbun Mfg. Co., Inc.
Jamestown, N. Y.

$2.50 WHY PAY MORE FOR CLEAR AMPLIFICATION?

use the



Republic Audio Frequency Tranformer
for all tubes
all stages

Circular on Request

FLINT RADIO CO.
1774 Wilson Ave.
Chicago, Ill.

HEATH

Radiant Condensers

Precise, when you examine them at the store and still more important, p-r-e-c-i-s-e **always.** Plates made PERMANENTLY FLAT, by the Heath process of stamping and hardening.

Micrometer-Adjusting Geared Vernier
Reducing gear, engaging with teeth cut into the outer rim of the vernier plate, affords infinitely delicate adjustment.

Jobbers and Dealers: Write Immediately for Proposition.

HEATH RADIO & ELEC. MFG. CO.
204 First Street Newark, N. J.

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The DE LUXE NEUTRODYNE

For Beauty and Distance

ALL PARTS MATCHED
ALL PARTS LICENSED

JUST PICTURE THIS—

1 DRILLED Radion Mahoganite Panel, engraved in Gold.
3 Four-inch Radion Mahoganite Dials, Gold engraved.
2 Gold Plated Jacks.
3 Genuine Hazeltine Neutroformers Mounted on the famous Comsco Bakelite End Condensers. Positively the only Neutrodyne Kit including these famous Comsco Condensers.
2 Hazeltine Neutrodons.
5 Bakelite Sockets.
1 6-Ohm Rheostat with Gold Plated Knob to Match Panel.
1 30-Ohm Rheostat with Gold Plated Knob to Match Panel.
2 Genuine Killark Completely Shielded Audio Transformers.
1 Mahogany-Finished Baseboard.
20 Feet Tinned Bus-bar.
1 .00025 Freshman Grid Condenser.
1 Tubular Glass Grid Leak.
1 Set Engraved Binding Posts.
1 .002 Micon Condenser.
1 .006 Micon Condenser.
Exact size special panel. Base blue print, and instruction sheet.
All packed in attractive partitioned box useful as a tool box.

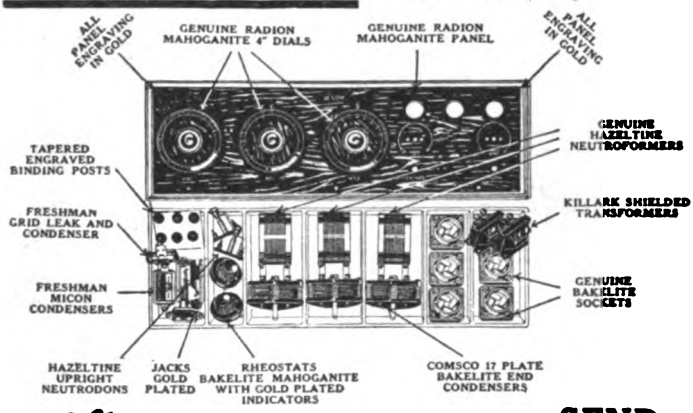
Written Money-Back Guarantee—
Orders acknowledged by return mail.
Shipped C. O. D. Send No Money.

LICENSED BY RADIO INSTRUCTORS INC. HAZELTINE PATENT NO. 1450080 OTHER PATENTS PENDING
NEUTRODYNE
REG. U.S. PAT. OFF.

5 TUBES

$34.49

Complete Assembly Kit to Build Your Own Genuine Hazeltine Neutrodyne


ALL PANEL ENGRAVING IN GOLD
GENUINE RADION MAHOGANITE 4" DIALS
GENUINE RADION MAHOGANITE PANEL
ALL PANEL ENGRAVING IN GOLD
GENUINE HAZELTINE NEUTROFORMERS
TAPERED ENGRAVED BINDING POSTS
KILLARK SHIELDED TRANSFORMERS
FRESHMAN GRID LEAK AND CONDENSER
FRESHMAN MICON CONDENSERS
GENUINE BAKELITE SOCKETS
HAZELTINE UPRIGHT NEUTRODONS
JACKS GOLD PLATED
RHEOSTATS BAKELITE MAHOGANITE WITH GOLD PLATED INDICATORS
COMSCO 17 PLATE BAKELITE END CONDENSERS

The RADIO-SHACK

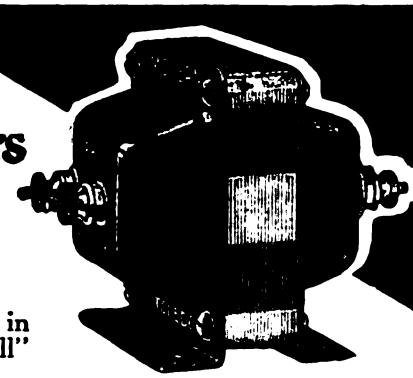
AMERICA'S GREATEST RADIO STORES
Executive Office, 55 Vesey St., Dept. PR 5
NEW YORK CITY

Goods shipped C. O. D. within 48 hours. Just pay the postman. Every article sold on WRITTEN money-back guarantee.

We answer every letter we get—same day we get it.

SEND NO MONEY

MODERN "Push-Pull" Transformers



—were used in the hook-ups illustrated and described on page 1419 of April "RADIO NEWS"; also page 13 March "RADIO IN THE HOME."

Radio authorities everywhere are unanimous in their endorsement of the MODERN "Push-Pull" method of power amplification.

Modern "Push-Pull"
Used in addition to one or two stages of audio. Assures clearer and better reception than has heretofore been secured from audio frequency reception.

Modern "Reflex"
This is the transformer that makes one tube do the work of three in the Monoflex Circuit. Ask for bulletin on the Monoflex Circuit.

Modern Standard Audio
4 to 1 ratio
Designed especially for use in 2-stage amplifiers. Provides greater audibility than three stages using ordinary transformers.

Sold by Good Dealers Everywhere

MODERN Transformers are guaranteed to give satisfaction. Ask your dealer for MODERN Transformers and new bulletin of latest hook-ups. If he can't supply you, write us giving dealer's name.

Modern Electric Mfg. Co. Toledo, O.

The Modern Electric Mfg. Co.
Toledo, Ohio

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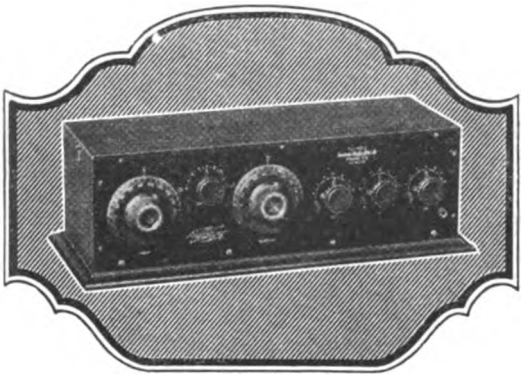
Coast-to-Coast Reception —*and beyond*



Radiodyne

"The Voice of the Nation"

NO LOOPS - - - NO AERIAL

With the **RADIODYNE** you can select broadcast programs from all parts of the country. Honolulu and London have often been picked up by operators in the central states without interference from nearby stations.

The Radiodyne is ready for operation by simply grounding to a water pipe or radiator, and throwing a few feet of wire on the floor. Uses any standard tubes—dry cell or storage battery. Extremely selective. Simple to operate—***Only two controls***—you can tune in on any program you wish—any wave length from 200 to 700 meters.

For use in apartments, boats, automobiles, railroad trains, etc., the RADIODYNE is enjoyable where other receiving sets would not be practicable.

PRICE $150.00

Write for illustrated folder which describes the RADIODYNE in detail. Every radio fan will be interested in this new type (antennaless) receiving set.

WESTERN COIL & ELECTRICAL CO.
308 5th St. :: Racine, Wisconsin

Just Trust Your Ears

One reason the MacMillan Arctic Expedition uses Trimm Headsets is that when a man's life may be at stake, he wants equipment best beyond question.

HEADSETS
LOUD TALKERS
PHONO. ATTACHMENTS

TRIMM

RADIO MFG. CO., Dept. 59
24 S. Clinton St. Chicago

TUBE INSURANCE. 91½% OF ALL TUBES ARE NEEDLESSLY DESTROYED

RADECO SAFETY FUSES *offer complete protection. Price 50 cents each*

RADIO EQUIPMENT COMPANY, 20 Stuart St., BOSTON, MASS

FOR SALE:
10 WATT SET FOR KEY OR BROADCASTING
For particulars write to
A. E. SCHILLING
108 Elm Street, Kalamazoo, Mich.
Will send photo on request. Station W. L. A. Q.

SOLDER WITH INSULATION
At Least 1,000 Miles More Distance
is the usual reward if you can solder without impairing the insulation of your set.
If you are building a radio-frequency amplifier you should read our free booklet:
"HOW TO SOLDER RADIO SETS"
Write for it
THE VALLEY FORGE CHEMICAL CO., Valley Forge, Pa.

The Sodion Tube

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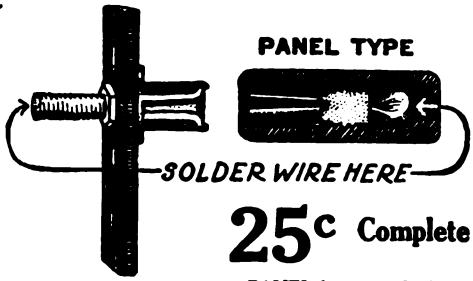
GOODBYE! BINDING POSTS and Wrong Connections



25c Complete

PANEL button only 10c
Cap only 15c

Here's a new method of quickly and positively connecting headphones, ground, antenna, Loud Speaker and a thousand other connections.

Follow the Colors — You Can't Go Wrong

Howard B. Jones

"COLOR CAP" CONNECTORS

Red + A
Green — A
Yellow — B
Blue + B
22½v
Pink + B
45 to 90v
Brown — Ant
Black — Ground

Hard rubber, all ends protected. Panel Button has panel disc to identify it. All caps in seven different colors.

Simple to connect. Solder connections positive contact. No metal part exposed. Neat and attractive—adds to the appearance of set. Ask your dealer or write us.

Dealers:
Send for prices. Packed 36 in counter display box. Ready for immediate delivery.

DOUBLE CAP TYPE

TAKE APART WITH SCREW DRIVER

30c Complete
Each Cap 15c

HOWARD B. JONES, 612 Canal St., CHICAGO, ILL.

RHAMSTINE* VICTOPHONE

For All Phonographs and Loud Speaking Horns

$7.50 Postpaid
Complete with Cord

In addition to the large diaphragm used in the Victophone, every other detail has been given the closest attention. When incorporated with your phonograph or horn, it will reproduce with the utmost volume and purest tone. No battery required to operate it. Your money back if not satisfied.

It can be furnished to fit all phonographs—the Standard Type fits the Victrola, Columbia, Jewett or Sonora. Specify make of phonograph when ordering. List Price, Standard Type, $7.50.

Order the New Victophone and test it before buying any other loud speaker

RHAMSTINE* MODEL B TYPE 3, AMPLIFYING TRANSFORMER

Especially Designed for Reflex Circuits, Ratio 5 to 1

$4.00
Postpaid

Years of success in manufacturing Audio Frequency Transformers prompt the statement that you can find no better unit than the Model B. In reflex usage, the Type 3—ratio 5 to 1—is highly efficient. Order yours and secure greater range and volume with your set.

Manufactured by

J. THOS. RHAMSTINE*

Woodbridge at Beaubien Detroit, Mich.

***Maker of Radio and Electrical Products**

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Free Parts for Your Radio Sets!

Your choice of these valuable premiums, free to you as a reward for securing only a few subscriptions to POPULAR RADIO

A FEW moments of your spare time spent in bringing POPULAR RADIO to the attention of your friends and acquaintances will yield you big rewards. Never before have we been able to offer such attractive and liberal premium values as these.

Glance over this broad list of radio parts and equipment that you can secure FREE, merely by introducing POPULAR RADIO to some of your friends and acquaintances who will appreciate the opportunity of subscribing to this most interesting and helpful magazine.

Show this copy of POPULAR RADIO to other radio fans. The pages of the magazine will speak for itself. Then send us the names of your friends, with $3 for each yearly subscription, and take your choice of any of the following premiums. They'll come to you *absolutely free.*

Any One of These for 2 Subscriptions:

Dubilier Ducon, and choice of any *three* Dubilier Micadon Grid Condensers of the following capacities: .00025; .0005; .001 or .002.

Pudlin Tubular Grid Leak (2 megs.); Dubilier Micadon Grid Condenser .00025; Cutler Hammer 6 ohm Rheostat, and *one* Alden Napier Socket, 201A or WD-11.

Three Pacent Jacks (*one* single circuit and *two* double circuit).

Bakelite Panel, size 7 x 18 inches.

22½ volt B Battery, large, choice of Burgess or Eveready.

One copy of Ballantine's "Radio Telephony."

Cutler Hammer 30 ohm Rheostat and choice of *one* Alden Napier Socket: 201A, 199 or WD-11.

Your Choice for Only 3 Subscriptions:

Bakelite Panel, size 7 x 24 inches.

Set of Mounted De Forest Coils; 35, 50, 75.

Amsco Compensating Condenser and choice of any *one* Alden Napier Socket: 201A, 199 or WD-11.

Two Cutler Hammer 6 ohm Rheostats and *one* Cutler Hammer Potentiometer.

Diode Dry Cell Tube and Cutler Hammer 6 ohm Rheostat.

"Scientific" Headset.

Big Value for 4 Subscriptions Each:

Lefax Loose Leaf Radio Handbook with full year's free supplement service.

Sleeper Variocoupler with switch lever and points.

Cardwell 21 Plate Condenser or General Radio 23 Plate Condenser.

Cardwell or Se-Ar-De 17 Plate Condenser.

Cardwell 11 Plate Condenser and Frost Jack.

U. V. 200 or C. 300 Vacuum Tube.

"Ampl Tone" Phones.

Free With 5 Subscriptions Each:

Cardwell 43 Plate Condenser.
Spiderweb Coil and Mounting.
Brandes or Holtzer. Cabot No. 4 National Phones.
Amertran Transformer.
Atwater Kent or Sleeper Variometer.

U. V. 201A or C. 301A Vacuum Tube.
U. V. 199 or C. 299 Vacuum Tube.
WD-12 Vacuum Tube.
WD-11 Vacuum Tube.

ALL premiums will be sent prepaid, immediately on receipt of your orders. If you want some particular part that is not listed here, write us and we'll tell you how many subscriptions you'll need to get it *free.* Or if you prefer *cash commissions,* just drop us a postcard asking for full particulars.

Renewals of old subscriptions or extensions of present subscriptions count the same for you as new subscriptions. In other words, any subscription you receive entitles you to your reward in cash or in premiums. Simply send us $3 to cover each subscription you take and we will send you your premiums.

Start today, and you'll have your required number of subscriptions in a jiffy!

POPULAR RADIO

Dept. 51 627 West 43d Street New York City

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THE HINES RADIO DESK

"A Complete Home for Your Radio Set"

Radio set owners all over the country are rapidly taking to the Hines Radio Desk as they quickly realize that it is just what they have been looking for. It was designed by an experienced radio man with the sole idea in mind of giving the owner a complete home for his radio set. Some of the special features are the large roomy top for receiving cabinets and loud speaker with ample elbow room left; two good size drawers for extra tubes, pliers, voltmeter, parts, etc., moulding on the back of top to protect loud speaker and receiving cabinets; spacious battery compartments that gets the batteries up off the floor and out of the way yet easily accessible at all times; acid proof rubber mat that lines the battery compartment; invisible steel fasteners on doors and many others.
Finished in Dark Red Mahogany and American Dark Walnut. Crated in a specially designed crate with two waterproof covers. If unable to purchase in your locality send name of dealer for further details and exact specifications.

Hines Radio Desk Company
Owensboro, Kentucky

ALL THE PARTS FOR
Latest Hook-ups

Large new catalog
just off the press

Dealers: Write for your copy today

R. S. PROUDFIT CO.
Distributors of Genuine RADIO Parts
143-145 South 10th Lincoln, Nebr.

WE REPAIR
The Following
RADIO TUBES

WD-11	$3.00	DV-6A	$3.00
WD-12	3.00	UV-199	3.00
UV-200	2.75	C-299	3.00
UV-201	3.00	UV-201A	3.00
C-300	2.75	C-301A	3.00
C-301	3.00	Marconi	3.00
DV-6	3.00	Moorhead	3.00
DV-1	3.00	6v.Plain Detector	2.75
DV-2	3.00	6v.Plain Amplifier	3.00

Mail orders solicited and promptly attended to.
Dealers and Agents Write for Special Discount.

H. & H. RADIO COMPANY
Clinton Hill Sta. P. O. Box 22-E. Newark, N. J.

Stand by!
3rd ANNUAL NATIONAL RADIO SHOW

The Most Important Event of the Year in the Radio World

It offers tremendous opportunities for display of Radio products right where thousands of Radio enthusiasts will see them.

Grand Central Palace
Main and Mezzanine Floors
New York City

October 2nd to 8th 1924
Inclusive

Every representative Radio firm should have its products featured in the THIRD ANNUAL NATIONAL RADIO SHOW. A nation-wide advertising and publicity campaign has already been launched.

For further details communicate with

AMERICAN RADIO EXPOSITION CO.
522 Fifth Avenue :: New York
Telephone: Vanderbilt 0068

"Profit Sharing With Exhibitors"

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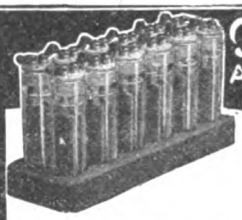


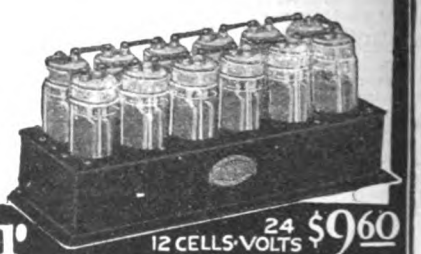
The RāBAT Junior $3.96

A Rechargeable Wet 'B' Battery. Capacity 800 Mil-Amps.
12 CELLS 24 VOLTS

Here are two acid type wet "B" radio batteries that are entirely free from internal current leakage. All elements visible through clear glass cells. RABATS have longer life with higher and more continuous voltage. Noiseless and compactly constructed—The Rabat Junior with a capacity of 800 mil-amps at $3.96 and the Rabat Senior with a capacity of 2800 mil-amps at $9.60 represent more actual battery value at a lower cost. More economical to buy—more economical to maintain. Easily recharged from ordinary house current. If your dealer cannot supply you send direct.

Prices F.O.B. Cleveland, Ohio

The Radio Rabat Company
714 Bangor Building, Cleveland, Ohio



The RāBAT Senior

12 CELLS 24 VOLTS $9.60
A Rechargeable Wet 'B' Battery. Capacity 2800 Mil-Amps. 48 VOLTS $17.88

Sterling

PORTABLE RECTIFIER

"The Battery Charger Without a Weakness"

AN old stand-by made according to latest radio improvements. A 5 amp. maximum charging rate. Number of contacts reduced to one. Freezing and sticking eliminated. Quiet in operation. Almost total absence of sparking. Connect to any 110 volt A.C. lighting circuit. Cannot be used incorrectly nor harm plates.

THE STERLING MFG. COMPANY
2843 Prospect Ave., Cleveland, O.

$16.00
West of Rocky Mountains $17.00

Better Tone for Your Radio!

FRANK D. PEARNE, famous Radio engineer, says TRANSCONTINENTAL RIBBON Aerials aid reception by combining maximum surface with minimum resistance. FORREST, eminent inventor, says, "I get best results by twisting Ribbon Aerial, 2 twists per 50 feet." Complete with snap hooks soldered to ends for instant attachment to insulators.

Transcontinental RIBBON COPPER AERIAL (Trade Mark)

50-Foot $1.50
75-Ft. $2.25
100-Ft. $3.00
150-Ft. $4.50

Clearer tone, greater volume, increased distance and selectivity guaranteed or **your money refunded!** Improves any set, tube or crystal. A laboratory product, with capacity, resistance and strength calculated to give better results.

Try It Without Risk! If your dealers cannot supply you, order direct from manufacturer, enclosing price. 100-foot length most generally used. Money-back guarantee protects you.

Acorn Radio Mfg. Co. 307 W. Lake St., Dept. 308 CHICAGO

TRANSCONTINENTAL RIBBON AERIAL

DEALERS! Write for Special Offer!

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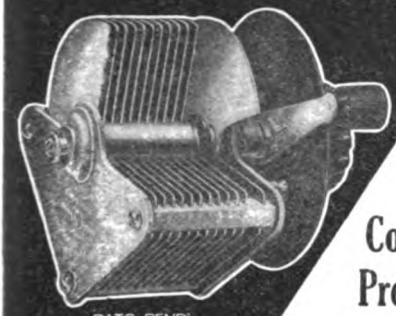
DUPLEX



PATS. PEND.

TRADE MARK
NONE OTHER

Compact Precision Condenser

A highly efficient product at an extremely low price.

Die-Cast Rotor. Milled End Posts, Novel and effective vernier.

Be sure to write for Bulletin "Taking the 'Con' out of Condensers."

Who's your Dealer or Jobber?

The DUPLEX ENGINE GOVERNOR CO., Inc.
50 Flatbush Ave. Extension
BROOKLYN, N. Y.

S. HAMMER RADIO CO.
303 Atkins Ave. Brooklyn, New York

COCKADAY 4-CIRCUIT TUNER

	List Price		List Price
1 Bakelite Panel 7x24	$3.90	2 Pacent Doub. Jacks	$1.60
1 Precision Cockaday Coil	5.50	1 Pacent Single Jack	.60
2 Amsco 26 Pl. Cond. 4" Dial	11.00	2 Amertran Transformers	14.00
5 Melco Tube Sockets	5.00	2 Amsco Switch Levers	.60
1 Amsco 6 Ohm Rheostat	1.00	3 48,000 Ohms Lavite Resistances	3.75
3 Amsco 20 Ohm Rheostats	3.75	1 .00025 Dubilier	.45
2 Amplex Grid Densers	2.50	1 .0005 Dubilier	.45
1 Durham Var. Grid Leak	.75	1 Pr. Como Dup. P. P. Transformers	12.50
1 Amsco 400 Ohm Potentiometer	1.50	1 Panel 1x12	.40
1 Bradleyleak	1.85		

GENUINE COMPLETE PARTS as listed above for the **Improved Cockaday 4-Circuit Tuner.** Exactly as specified by Mr. Cockaday List price $69.00. SPECIAL KIT PRICE **$55.00**

The above parts may be bought separately. Write for our catalogue

Orders over $5.00 Shipped Prepaid, Money Orders or C. O. D. One-third must accompany all C. O. D. orders. Not insured unless insurance charges included.

CARTER
Vernier Rheostat

6 ohms. $1.50
20 or 30 ohms. $1.75

New original construction.
Only one hole to drill, mounts like a jack.
Only one control.
No scraping or scratching.
Vernier control all the way.
Send for Illustrated Catalog.

Carter Radio Co.
1807 REPUBLIC BUILDING
CHICAGO

The BELL Dial

For Your Protection

BELL molded bakelite Sockets and Dials are sold in individual blue boxes, branded with the BELL trade mark. Every socket or dial reaches you smooth and clean, without a nick or scratch. Use BELL Dials and Sockets for your pet hook-up.

The BELL Dial

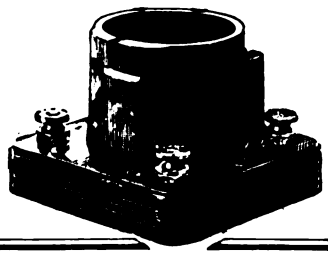
Highly polished molded bakelite (*not* composition). Clean white engraving. Accurate brass bushings that will not wabble on the shaft. Being bakelite, these dials are strong mechanically, are unaffected by moisture and temperature, and are fast color. In 2, 3, 3½ and 4 inch sizes. Made also with hole through knob for vernier attachment. Vernier knob to match can be supplied.

The BELL Square Socket

One-piece molded bakelite, for base or panel mounting. Its unusual double-wipe spring contact makes firm sure contact with tube prongs, even after constant use. Gets the best results from your tubes.

Dealers: If your jobber does not carry BELL Radio Products, write us for circular on molded sockets and dials.

Bell Manufacturing Co.
12 Elkins St. Boston 27, Mass.



The BELL Square Socket

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"SPIKE"

The Stations You Receive in a

Kasper Radio Record Book

Then you will know where to set the Dials, Switches and Rheostats to bring them back. This book is indorsed by thousands of professional Radio Fans in all parts of the country because it covers everything on the panel. (Copyrighted.) Can be used with any set. Contains up-to-date list of 1,100 Broadcasting Stations, Time of Principal Cities and instructions HOW TO RECORD STATIONS. 24 pages, valuable information. No set complete without one. 50c a copy, Postpaid. For your convenience enclose a $1.00 bill for 2 copies, otherwise send a money order for 1 or more. No checks nor stamps.

We also furnish Kasper's "APPLAUSE CARDS" printed on stamped postal cards. 25 mailed anywhere upon receipt of 50c.

KASPER BROTHERS COMPANY

317 Lorain Street Bank Bldg., Cleveland, Ohio, U. S. A.

TYPE AI
$25.00
21" Fibre Horn

The TRINITY LOUD SPEAKER

The Trinity Loud Speaker is an instrument that combines the best qualities of a phonograph reproducer in combination with electro-magnetic principles best fitted for radio amplification.

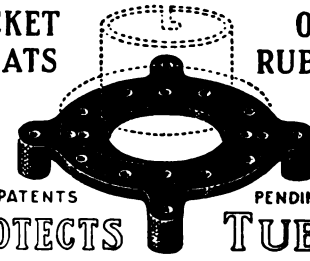
Perfect reproduction of all music and speech without distortion. No storage batteries required. The instrument is of a heavy duty type and is guaranteed fully by the manufacturers.

For sale by good dealers
Literature upon request

TRINITY RADIO CORPORATION
446½ Tremont Street, Boston, Mass.

ILLINOIS SOCKET CUSHION

SOCKET FLOATS ON RUBBER



PROTECTS TUBES

Cushion is moulded of pure gum rubber that absorbs all vibrations that would otherwise reach Tube. It is not a mere pad or washer. It is held to socket separately by 2 small screws and nuts and will fit any socket, round or square, for large or small Tubes. Just the mounting for portable camp sets and Superheterodyne.

Price, 35c. Each—3 for $1.00, Post Paid

At your retail store. If your dealer doesn't have them, order direct.

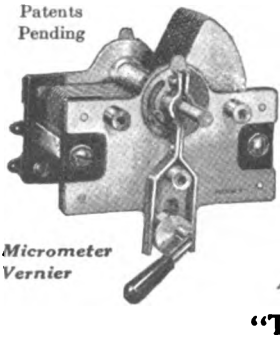
ILLINOIS RADIO CO.
Springfield, Ill.

NEW MODEL "B" HAMMARLUND

Grounded-Rotor Precision Condenser

A Laboratory Product

Patents Pending



PRICES for Panel Mounting

43 Plate	.001	Mfd.	$7.00
23 "	.0005	"	6.00
17 "	.00007	"	5.75
13 "	.00025	"	5.50
3-½" pure Bakelite Dial			.75
4" pure Bakelite Dial			1.00

At your dealer's otherwise send purchase price and you will be supplied postpaid.

The advanced design represented by the new Model "B" Hammarlund gives every essential the well informed radio builder demands—

(1) Lowest loss (too small to measure).
(2) Micrometer Vernier control.
(3) Soldered Brass plates to reduce series resistance.
(4) Rotor grounded-to-frame avoiding all hand capacity effects.
(5) Heavy, large face contact bearings to rotor.
(6) Adjustable cone bearings.
(7) Brass plates for rigid construction add electrical efficiency.

"The Condenser of Super-Qualities."

WRITE FOR DESCRIPTIVE CIRCULAR **HAMMARLUND MFG. CO.** 144 W. 18th St. NEW YORK

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TRADE MARK

ELECTRASOTE

REG. U.S PAT OFF

RADIO PANELS

Cost 25 to 50% Less

Recently introduced by The PANTASOTE COMPANY, Inc. Electrasote has highly desirable radio-electric properties—greater volume and surface resistivity than any other panel, therefore less surface-leakage and power-loss in the set.

Remember—a good panel deserves proper handling: Use a new *sharp* drill with *slight* pressure.

All Standard Sizes at good Radio Dealers

JOBBERS AND DEALERS:

Write for our interesting proposition.

M. M. FLERON & SON, INC.

Exclusive Sales Agents for Electrasote Radio Panels

Trenton, New Jersey

$8

14" Fibertone, $12.50

A phone plus a FIBERTONE makes a beautiful musical instrument

Beautiful Tonal Reproduction

The reproduction of radio music and speech in the home through the Fibertone, is an example of the true tonal quality given by a horn of fiber. One phone from any good head set, when coupled with the Fibertone, renders the broadcast program with wonderful clearness, free from metallic noises. The attractive outward appearance of the Fibertone is significant of the inward beauty that permits such supremity of reproduction.

If your dealer cannot supply you write direct.

FIBER PRODUCTS COMPANY

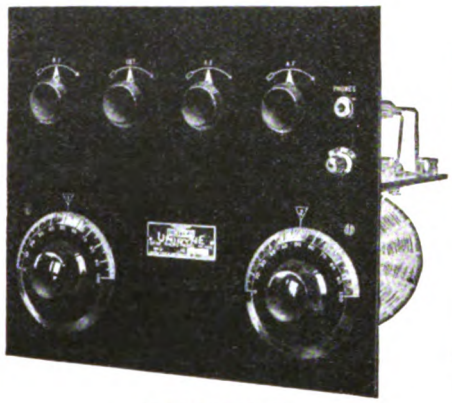
34 Orange St. Bloomfield, N. J.

FIBERTONE

RADIO HORN

Introducing—

the Greatest Achievement of a Broadcast Receiver



UNITED

Reg. U. S. Pat. Off. **UNIDYNE** Pat. Pend.

RECEIVER

Again the vast resources of *United* have made possible another brilliant triumph—the "UNIDYNE" RECEIVER.

We have produced a four-tube radio receiving instrument embodying every desirable feature:—Simple in operation, will not oscillate or reradiate, has super selectivity, receiving efficiency and purity of tone.

There are but two tuning dials which, with surprising sharpness, cover the entire range of broadcasting wavelengths. No need to wait until a local "silent night" to enjoy programs from distant stations.

The United "UNIDYNE" will equal the performance of any five-tube set. It will always bring in stations at the same recorded setting of the two dials.

The United "UNIDYNE" Receiver will make readily available to you everything necessary to the fullest enjoyment of all there is in Radio.

The pleasing design of the cabinet, either solid mahogany or walnut, and its beautiful finish make it an ornament to any home.

Ask a United dealer to demonstrate the "UNIDYNE" or write us for literature and prices.

Distributors will find an interesting proposition awaiting them.

UNITED MFG. & DISTG CO.

9705 Cottage Grove Ave.

Chicago, Ill.

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ACCURATUNE
MICROMETER CONTROLS

"There's that Station"

"I have just tuned in on my Accuratune-equipped set, and with the ease of an amateur. For hours I've worked over that station with the old fashioned dials, and even vernier plate condensers. Now, with the slightest twist of the knob I pull in stations I never heard of.

"The Accuratune is not a mere dial but an actual Micrometer Control more efficient than vernier condensers or any tuning device, and far more simple to operate."

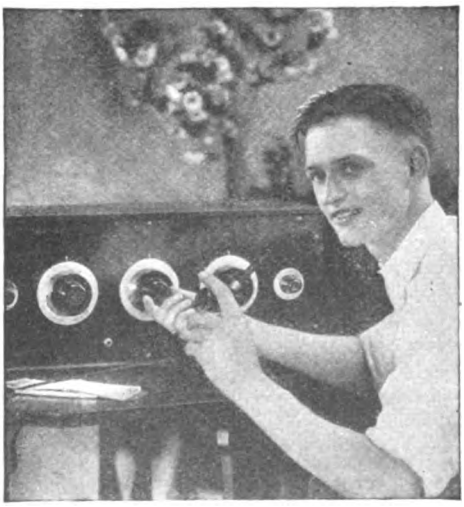
Designed for either coarse or precise tuning and to fit all standard condenser shafts. Price $3.50.

The Mydar Radio Company
9-B Campbell Street :: Newark, N. J.
Radio Ltd., Montreal, Canada
Canadian Representatives

For the Phonograph

The Accuratune Phonograph Attachment is applied instantly to the reproducing arm and converts your phonograph into a loud speaker. Permits the whole family to enjoy broadcast music.

$10.00



A 2c Stamp
Brings this Loop on Trial

COMPARE reception on your present aerial with reception on this new IMPROVED Loop—*at our expense!* Put our claims of selectivity, directional capacity and sensitivity to the test, *on your set*, in *your own home*. 10 days in which to make every conceivable experiment. 10 days to find out *all* about this loop before you buy it. Unless it entirely satisfies, you may return it or have your money promptly refunded. Select your type and send C. O. D. order NOW!

Type A-737 (300-700 meters) 6 inches square—non-directional.....$10
Type A-7216 (175-1000 meters) 6 inches square—non-directional.....$12
Type B-2537 (300-700 meters) 18 inches square—directional.....$20
Type BL-2520 (200-18,000 meters) with honeycomb coil mounting. 18 inches square—directional.....$25

Send for Bulletin 1-102

V-DE-CO RADIO MFG. CO., Dept. F. Asbury Park, N. J.

The Copper Giant "A" Battery
For UV199 and WD11 tubes

FIVE TIMES THE LIFE OF A DRY CELL
No deterioration when idle

At your dealer's or postpaid for $1.35 each. Renewals 50 cents each. Write for circular

THE COPPER GIANT BATTERY CO., Landsdowne, Pa.

LOUD SPEAKING CRYSTAL SET

Stations brought in from over 1000 miles and music heard all over the room right from your present crystal set with the STEINMETZ AMPLIFYER. Get our complete catalog.

STEINMETZ WIRELESS MFG. CO.
5703 Penn Ave., Pittsburg, Pa.

YOU DON'T NEED TUBES to hear programs from stations 400 to 1000 Miles Away. I can show you how to get them on YOUR CRYSTAL SET. Changes often cost Less Than One Dollar. Send self-addressed envelope for picture of my set.

LEON LAMBERT
540 So. Volutsia, Wichita, Kansas

Use — Price 75¢
DURHAM
Variable Grid Leak
At dealers, or postpaid
Durham & Co., 1936 Market St., Phila.

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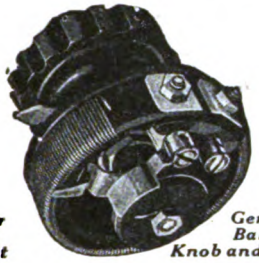
KING QUALITY
ALL THE NAME IMPLIES
RADIO APPARATUS



Detector Vernier Rheostat

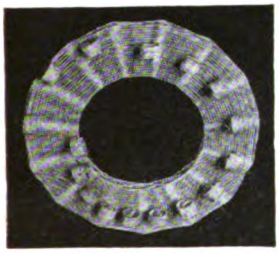
Genuine Bakelite Knob and Base

THE KING QUALITY LINE COMPRISES:

Adapters	Dials	Rheostats
Bakelite Knobs	Inductance-	Switch Levers
Binding Posts	Switches	Vacuum Tube-
Contact Points	Panel Mountings	Sockets

RADIO DIVISION
KING SEWING MACHINE CO.
BUFFALO NEW YORK

KING QUALITY (K)



SICKLES
DIAMOND WEAVE
INDUCTANCE COILS

VARIOMETER and VARIOCOUPLER

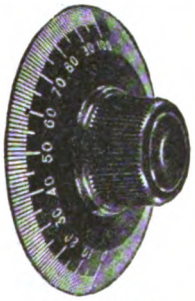
Variometer - $4.50
Variocoupler - - $4.50

THE F. W. SICKLES CO.
Successors to
RADIO MANUFACTURING CO.
Dept. B. 337 WORTHINGTON ST., SPRINGFIELD, MASS.

NA-ALD
De Luxe Dials

The artistic qualities of Na-ald De Luxe dials distinguish these dials as truly beautiful. They add to the appearance of any set in which they are used.
Na-ald Dials have a high gloss finish. They are moulded of genuine Bakelite and have patented construction. Dials are matched and made in 2", 3", and 3¾" sizes.

Alden Manufacturing Company
Largest makers of Radio sockets and dials in the world
Dept. C 52 Willow St.
Springfield, Mass.



No. 3003—4
3 Inch
35c, 3 for $1.00

SHAMROCK
FOR SELECTIVE TUNING

LIST $20

You'll be neighbor to Havana

WITH the new Shamrock Kit you can build a set that pulls in stations 3000 miles away. You can get distant stations while the local stations are going full blast—due to the wonderful selective capacity of sets built with this kit. The kit is equipped with two wonder working Shamrock balancing condensers—also three Shamrock air core transformers mounted and properly balanced on U. S. Tool condensers—made expressly for Shamrock.

Inspect this kit at your dealer's today. You will be impressed by the high quality and finish of each instrument in it. If your dealer hasn't the kit in stock, send us the coupon below.

SHAMROCK
MANUFACTURING COMPANY
Dept. 90, Market St., Newark, N. J.

CLIP THIS COUPON

SHAMROCK MFG. CO.,
Dept. 90, Market St., Newark, N. J.

Gentlemen:
Send me information on your Shamrock Kit.

Name.....

Address.....

Dealer's Name.....

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Your Choice! —for Only 35 Cents in Stamps!

Hundreds of reliable hook-ups and circuit diagrams—practical hints and handy knacks—money-saving tips and pointers on how to make and improve your own sets. Take your pick of all this authoritative information on radio!

PERHAPS you haven't realized what a tremendous amount of information is available in the back issues of POPULAR RADIO. Since the first number was published, May, 1922, literally hundreds of requests have come to us for these valuable back issues of POPULAR RADIO which contain so many practical hints and worth-while suggestions.

There are still a few copies left of many of these back issues. *While they last* you can take your pick of them at only 35 cents each, to cover cost and mailing. Here's your opportunity to complete your files of POPULAR RADIO and to add to your store of information on just the subjects which interest you.

Glance over this partial list of contents of each issue. Then tell us which ones you want, enclosing stamps, check or money order to cover your requirements. Our stock is getting very low, so don't delay taking advantage of this offer!

May, 1922

—Harnessing waves to wire.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How electricity is generated.
—Tones that do and don't broadcast.
—How to make a simple tube Receiving Set.

July, 1922

—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—How to make a variable condenser.

September, 1922

—How to build the Armstrong Circuit Receiver.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922

—How to make a spider-web tuner.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922

—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—The most popular transmitting aerial.
—How to make a novel variocoupler.

December, 1922 (Out of stock.)

January, 1923

(Out of stock. A Reprint of Mr. Cockaday's article describing the DX Regenerative Receiver may be had for 22 cents.)

February, 1923 (Out of stock)

March, 1923 (Out of stock.)

April, 1923

—Regeneration without Radiation.
—How to make a simple single tube Receiving Set.
—Circuit diagram of the Cockaday DX-3 Circuit Tuner, with instructions on how to add three stages of radio frequency.

May, 1923

(Out of stock. A full description, however, of Mr. Cockaday's original 4-Circuit Tuner will be found in POPULAR RADIO'S handbook, "How to Build Your Radio Receiver," advertised on page 108.)

June, 1923

—How the microphone transmitter works.
—How to build a good single tube receiver.
—How to make a crystal detector stand.

July, 1923

—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

August, 1923

(Out of stock. A full description, however, of the Tuned Radio Frequency Receiver will be found in POPULAR RADIO'S handbook," "How to Build Your Radio Receiver," advertised on page 108.)

September, 1923

—How to get a radio license.
—How weak signals are regenerated.
—How to make a battery charging rectifier.
—How to build the Haynes DX receiver.

October, 1923

—Practical hints for Coil Calculations.
—How to make a Two-stage Audio frequency Amplifier.
—Ten good rules for Broadcast Listeners.
—How to make a simple Honeycomb Receiver.

November, 1923

—The 100 Best Hook-ups (Part 1)
—Receiving without Antennas.
—How to build the New Regenerative Super-heterodyne Receiver (Part 1.)
—How to build a combination Short and Long-wave Receiver.

December, 1923

—How to Select your Radio Parts.
—The 100 Best Hook-Ups (Part 2).
—How to Read a Diagram (Part 1).
—How to Build an efficient Crystal Receiver.
—How to Build the Super-heterodyne Receiver (Part 2).

January, 1924

—How to build the "Improved" Cockaday 4-Circuit Tuner.
—The 100 Best Hook-ups (Part 3.)
—How to Read a Diagram (Part 2.)
—List of U. S. Broadcasting Stations.
—How to build the coupler, oscillator coupler and r. f. transformers for the Super-heterodyne.

February, 1924

—How to add "Push and Pull" amplification to the original 3 tube Cockaday 4-circuit tuner.
—The original 4-Circuit Tuner as a Portable Set with Loop.
—The 100 Best Hook-ups (Part 4.)
—How to build a 3-tube Reflex Receiver (Part 1.)

March, 1924

—Hoffman Transformer Measurement Chart.
—The 100 Best Hook-ups (Part 5)
—How to Build an Amateur Transmitter.
—A 3-tube Reflex Receiver (Part 2).

April, 1924

—How to Build a Simplified Neutrodyne Receiver.
—The 100 Best Hook-ups (Part 6).
—How NOT to Tune the Single Circuit Receiver.
—A Novel Substitute for "B" Batteries.

POPULAR RADIO, INC.

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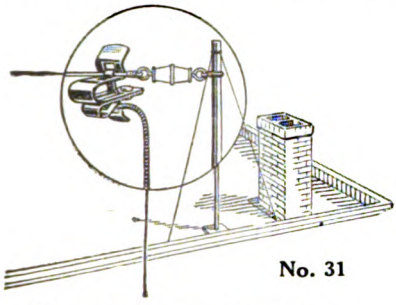

No. 31

The Antenna Connector

Snap larger connector over Antenna Wire; insert Lead-in Wire into smaller clip and a perfect connection is the result.

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Equipped with Fahnestock Patent Wire Connectors Easily Attached.

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Loud Speaker

To hear a radio concert reproduced by Morrison creates an instant desire to own one of these faithful Loud Speaking Units. For it seems like magic to hear so truly the singing quartet and the sweet-toned violin. Even with full volume no harshness nor vibration creeps in.

Then too Morrison is adjustable — turn a little dial and regulate the volume to your taste. It isn't surprising that once you own a Morrison you cannot be satisfied with less. Distant stations are unbelievably loud and clear and you can soften the tone if you wish.

Every Morrison carries a "money-back" guarantee.

Handsomely Nickel Plated

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Complete with 5 foot cord

Free two color catalog on request

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The market on Morrison is active. Our merchandising plan will interest you. Write immediately for details and discounts.

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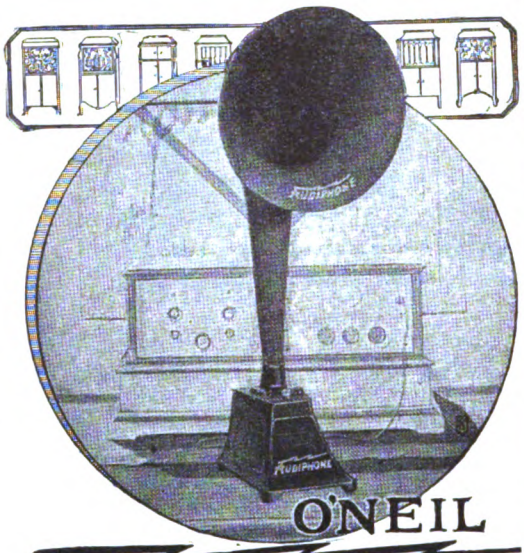

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THE **Audiphone** began beyond the limits of the average "loud speaker." Radio acoustic engineers and phonograph craftsmen coordinated the tone principles of the finest phonographs with those of radio. The result is a NEW naturalness. Sensitive enough to perfectly amplify the weaker signals, and flexible enough to reproduce on a neutrodyne, superheterodyne or other multiple sets without rattle or chatter. Satisfaction or your money refunded. At most good dealers, or you can order direct, giving your dealer's name.

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Beautiful Antique Bronze Finish. No extra batteries needed. Complete, with connecting cord.

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14 Inch Horn

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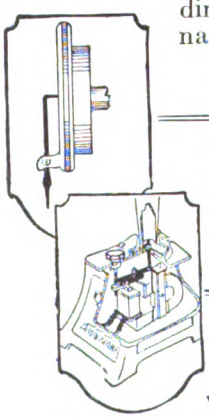

Note the similarity of construction between the phonograph reproducer (illustrated in the upper panel) and the reproducer of the O'Neil *AUDIPHONE* (below): both have a mica diaphragm set in a sound-box chamber actuated by an elbow stylus bar.

O'Neil Mfg. Co.

714 Palisade Avenue

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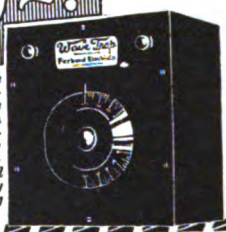
$200 SELECTIVITY for $8.50!

We guarantee that the Ferbend Wave Trap, when properly connected to any workable receiving set, will tune out any interfering station.



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You will find it a valuable addition. It is designed and manufactured complete by us, after years of careful experimenting. It is not to be confused with imitations hastily assembled from ordinary parts. The price is $8.50. Shipment is made parcel post C. O. D. plus a few cents postage. If you prefer, you can send cash in full with order and we will ship postage prepaid. Send us your order today.

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of United States, Canada and West Indies with indexed booklet Broadcasting guide.

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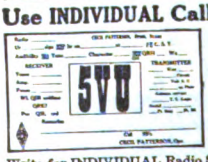

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Radiograms: Same prices.

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CONTROL-O-METER

The Control-O-Meter is available from good dealers in most sections of the country—if, however, you have any difficulty in securing one, we will ship direct, postpaid on receipt of price—**$12.50.**

You don't need a new set to hear radio programs one at a time. Add a Malone-Lemmon Control-O-Meter to your present set and you immediately add the power of selectivity. Selectivity which will allow you to hear any station within the range of your set without interference from another.

The Malone-Lemmon Control-O-Meter works equally well with *any* type of set regardless of your location or antenna.

Send for literature describing the Control-O-Meter and other Malone-Lemmon Products.

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EVERY condenser bearing the United Scientific Laboratory stamp is a precision product! Bakelite ends! Pure Aluminum Plates. Accurate spacing! Extra rugged bearings. A condenser that has such low losses it will double the efficiency of your set.

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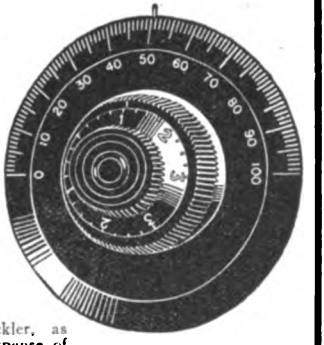
is two dials in one with a 40 to 1 ratio.



"EZTOON" dials make possible vernier adjustment of vario-coupler, variometer rheostat, potentiometer, or tickler, as well as saving the expense of a second set of adjustable plates on condensers.

The "EZTOON" gives unusual close tuning so essential in Heterodyne, Acmedyne, Neutrodyne and tuned radio frequency circuits.

No panel holes to drill. Just take off old dial, slip on "EZTOON" dial and tighten set screw.

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bring in stations that heretofore you have passed up as impossible.

Get and hold stations.

Use it on any and all types of receiving sets to obtain vernier adjustment unobtainable before.

Tune in DX stations you never heard before.

Obtain vernier adjustment of all tuning instruments within your set.

BUTLER MANUFACTURING CO.

3236 W. Washington St., Indianapolis, Ind.

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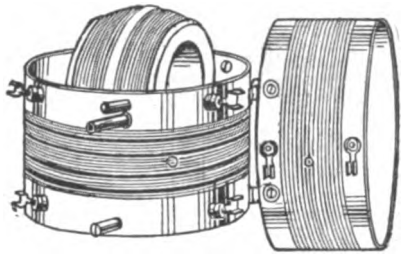
GUARANTEED IN USING THE
Eastern Coupler
FOR THE SUPERDYNE CIRCUIT



Most improved design and finest workmanship.

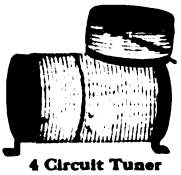
Wound with double silk wire on genuine Bakelite Tubing.

Picture hook-up and material list free with each coupler. **Price, $6.00.**

Eastern Coil Sets
FOR THE COCKADAY CIRCUIT

are the Standard, and in Universal use due to their Proved Efficiency in this wonder circuit.

Made as per specifications of Mr. Cockaday, "D" Coil hank-wound. Complete assembled set of B, C and D Coils on GENUINE BAKELITE TUBING, wound with No. 18 double silk covered wire..... $4.25



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Original and new hook-ups with material lists FREE with each set of coils.

GENUINE LAVITE RESISTANCE

48,000 ohm Price $1.50

These resistances *control* the *tone* of the Cockaday Circuit and eliminate all transformer distortion; modulating the tone after the fashion of the best of phonographs.

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For fine filament control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market.

Complete with Knob

6-Ohms.....$1.25
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Fifteen Taps But Only One Drill Hole Required!

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of holes. No more chipped panels. Complete with hard rubber Knob and Dial.

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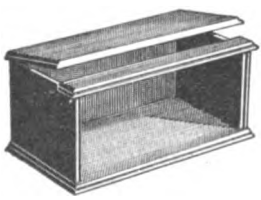

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Made of extra dry high-grade lumber, in solid Mahogany or Walnut, also, Mahogany or Walnut high piano rubbed or bright finishes.

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Panel Sizes	Walnut or Mahogany Finish	Genuine Walnut or Mahogany
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Gets distant stations easily and clearly. Hundreds have substituted this quality coil for those of inferior make, and are amazed at the improved reception, selectivity and general D-X results.

Y. M. C. A. Secretary, Wilmerding, Pa., says, "We've been getting KHJ in Los Angeles on three tubes (WD-11) but since installing your coils we now get KHJ on the detector alone, a distance of 2300 miles, and much clearer."

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At your dealers, otherwise send purchase price and you will be supplied postpaid.

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This may be the trouble with YOUR set—

You can probably change your grid leak for higher

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The highest efficiency can only be obta.ned by chang.ng both resistor and condenser

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EQUAL to the widest range of reception requirements. **Marle Transformers** amplify the weakest broadcasting, over frequencies all the way up to 3500 cycles without variation. Perfect tone quality. Utter absence of howling or distortion. To get the most out of radio—use **Marle Transformers.**

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$3.75

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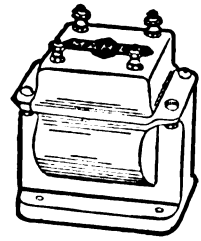

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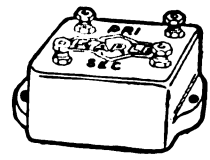

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THE Popular Radio Handbook has been the sensation of the season. Eager fans exhausted the first edition almost before it was off the presses.

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All working details are given—the list of parts required and their approximate cost; complete hook-ups and circuit diagrams and ***how to read them;*** illustrations making all points clear, and simple instructions on how to assemble, mount, wire and operate each set.

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—How to build a 5-Tube Tuned Radio-Frequency Receiver.

—How to build the 5-Tube "Improved" Cockaday 4-Circuit Tuner.

—How to build the Regenerative Super-heterodyne Receiver.

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—How to read a Diagram.

—How to put up an Outdoor Receiving Antenna.

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—Ten good Rules for Broadcast Listeners.

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In this new book edited by Mr. Banning and Mr. Cockaday, you will also find scores of valuable suggestions about aerials, how to select your parts, how to install your set, tips on tuning and how to learn the code.

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"'How to Build Your Radio Receiver,' is one of the most complete books of its kind I have ever seen. I wish that all the books that come to my notice were as worthy of commendation as this one."
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New York Evening World.

"Mr. Banning and Mr. Cockaday have compiled a book which deserves to rank high in the estimation of amateur set builders. The typography is excellent, the diagrams clear and easily read, and the whole manner of presentation far superior to anything that has thus far been attempted by a radio publisher."
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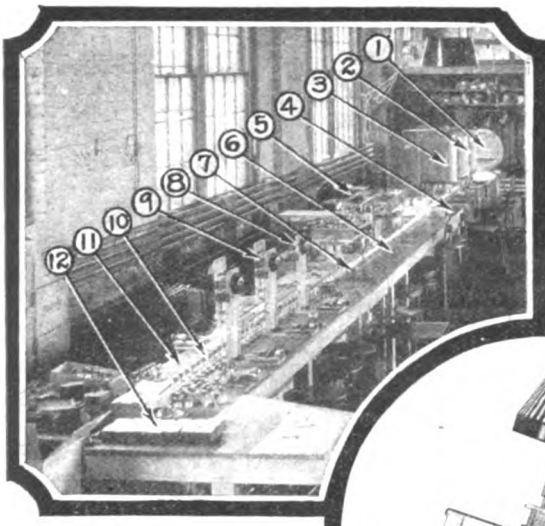
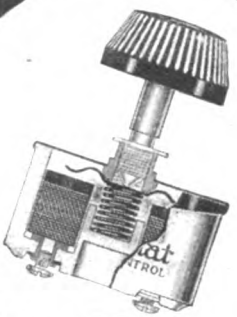


View of one production line in Bradleystat assembling department. The conveyor assembly process was developed to keep up with the increasing demand for Bradleystats and Bradleyleaks. See explanation below.

View of one production line, showing operators assembling Bradleystats and packing them in cartons for shipment. All parts are fabricated in other departments. The electric furnaces are in a separate building.



How the Bradleystat is made

FOR over twenty years the Allen-Bradley Co. has made graphite disc rheostats for battery chargers and motor starters. The experience gained during these twenty years is embodied in the most perfect filament rheostat used in radio, the Bradleystat.

Today, the Universal Bradleystat, with its two columns of graphite discs under adjustable pressure, provides unequaled control for radio tubes. Its control is absolutely noiseless, stepless and of exceedingly wide range.

Bradleystats are assembled by the most modern methods and tested rigidly before they are shipped.

The illustration above depicts the assembly process that guarantees a uniform product for the radio fan.

1—Cleaning porcelains
2—Riveting terminals
3—Threading terminals
4—Inserting terminal screws
5—Disc-filling machine
6—Inserting pressure springs
7—Installing cover plates
8—Inserting adjusting knobs
9—Six testing machines
10—Conveying Bradleystats
11—Inspecting Bradleystats
12—Packing Bradleystats

Bradleyleaks follow the same process, except for the use of different discs and the installation of condensers.

Install Bradleystats in your radio set, if you want the finest filament control obtainable. Try one, and experience new delights in radio reception.

Allen-Bradley Co.
Electric Controlling Apparatus
276 Greenfield Avenue
MILWAUKEE, Wisconsin

For Sale at All Dealers

BRADLEYSTAT	$1.85
BRADLEYLEAK	1.85
CONDENSER (.00025 mf.) .	.35

THE ALLEN-BRADLEY CO. HAS BUILT GRAPHITE DISC RHEOSTATS FOR OVER TWENTY YEARS

PRESS OF WILLIAM GREEN, NEW YORK

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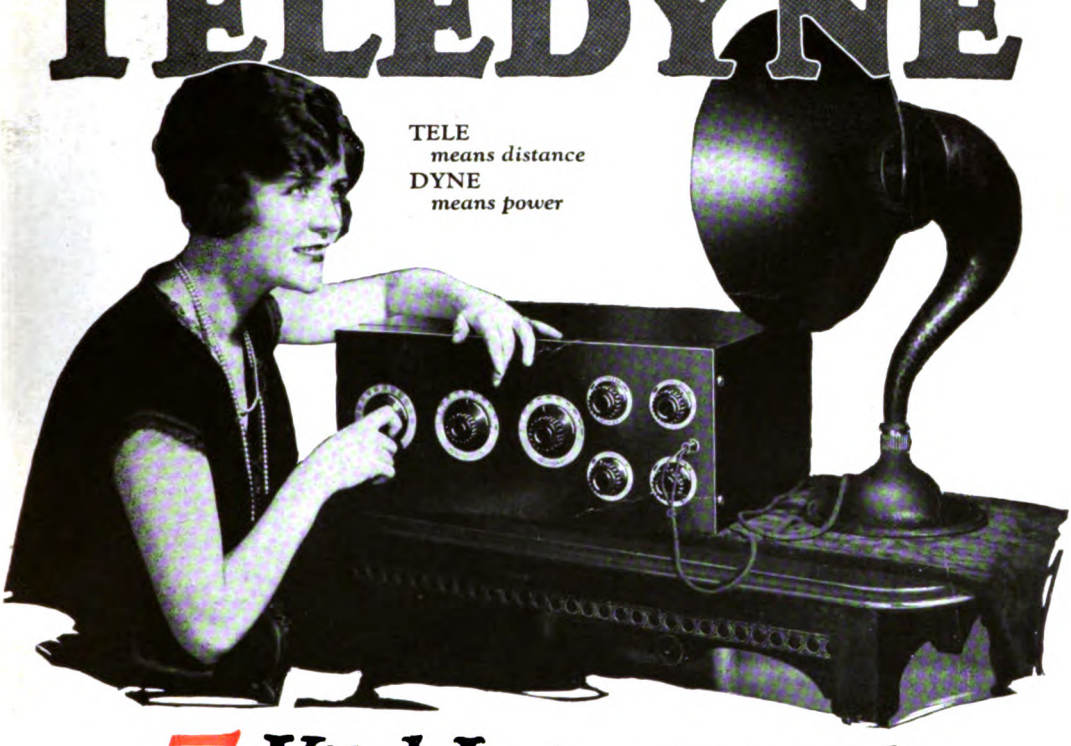
TELEDYNE

TELE
means distance
DYNE
means power



5 *Vital Improvements in Radio*

Dr. Cutting and Mr. Washington have struck at the very heart of the radio problem in the development of the TELEDYNE —1924's greatest set.

1. TELEDYNE is super-sensitive, catching and developing the weakest signals.
2. Extremely selective—TELEDYNE tunes local stations *out*.
3. Greater volume—a real LOUD-speaker set.
4. NO radiation—no regeneration howls on the air.
5. Easy to pick up new stations—no need for a "log."

Four tubes do the work of five, saving tubes and batteries. Price, complete with all tubes and batteries, contained in cabinet $190

See the Console Model, complete with Loud-speaker.
Ask a C&W Dealer to demonstrate

The Cutting and Washington Radio Corp., Kasota Bldg., Minneapolis, Minn.

Cutting and Washington

Standard of Excellence in Radio Since 1914

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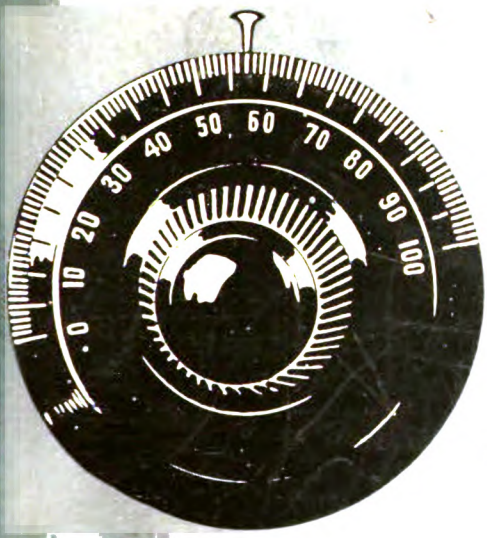
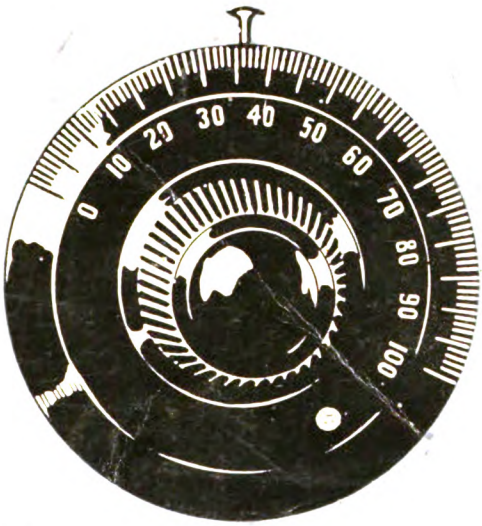
Popular Radio

25¢

Edited by KENDALL BANNING

JUNE 1924





How to Make a Regenerative BROADCAST RECEIVER for Use with a Short Indoor Antenna

★

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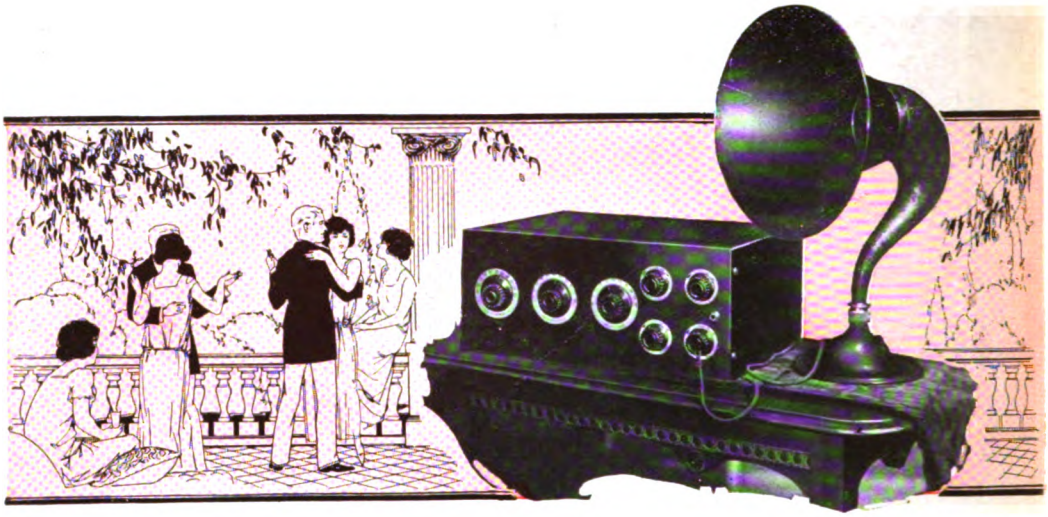

Enjoy Radio This Summer

YOU can get good programs the year round with a *good* receiver — the C & W TELEDYNE.

Dr. Cutting and Mr. Washington have given you 5 vital improvements—greater sensitivity, greater volume, sharper selection, longer range — WITHOUT COMPLICATED, HARD-TO-TUNE APPARATUS.

TELEDYNE is as easily operated — as certain to give you your station as the "old reliable" regenerative sets. No need to "log" stations. Hunt the air at will. A step ahead of neutrodyne.

Ask for a demonstration
at nearest C&W Dealers

THE CUTTING & WASHINGTON RADIO CORP.
Minneapolis, Minn.

The new Cutting and Washington

TELEDYNE

TELE *means distance-* **DYNE** *means power*

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Radio Reception
—more perfect this summer!

Tremendous improvements in sending and receiving combine with better programs to provide the best of radio fun!

This is indeed a radio summer! The vital interest of the presidential campaign—waged right in your own home. The glorious and inspiring church services. The important sporting events, market reports, home hints, intensely interesting talks, gay music—all these diversions are brought directly to you.

Why Sending Is Better

Last summer many high power broadcasting stations operated on a single wave length. This summer they are spread over a wave band. You may choose at your will. Sending stations have greatly increased their power and are spreading their programs over many more miles. Broadcasting from interconnected stations includes many people who would formerly have been deprived of the unlimited pleasures of radio.

For sixteen years the Brandes name has consistently stood for service—for skill—and dependability.

Table-Talker - **$10.00**
50c additional west of the Rockies
In Canada - - **$14.00**

Navy Type Headset **$8.00**
In Canada - - **11.00**

Superior Headset - **$6.00**
In Canada - - **7.00**

Why Reception Is Clearer

Sets have been vastly improved. They are more keenly selective, more sensitive, more satisfactory generally. Vacuum tubes have been redesigned, new circuits have been developed. New loudspeakers, assuring accurate and true reproduction, have been put on the market. In fact, the combination of finer programs, stronger sending and clearer reception now makes the mavels of radio an active part of every day life.

All Brandes Products are sold under a money back guarantee by reliable dealers everywhere.

Brandes

The name to know in Radio

©C. Brandes, Inc., 1924

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(Cover design by Frank B. Masters)

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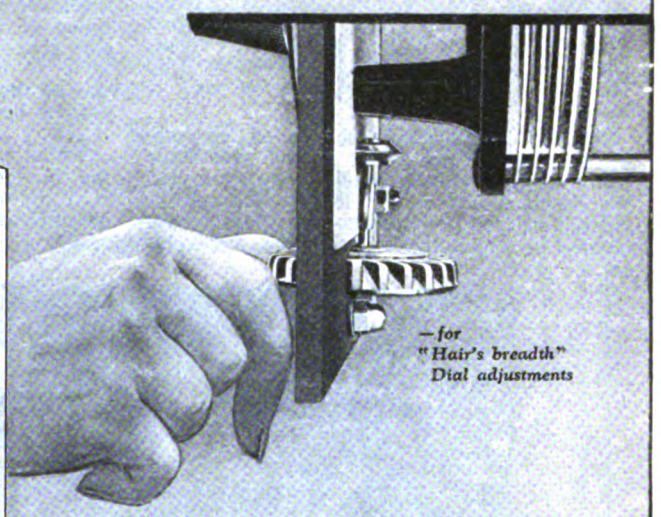
The GREBE TANGENT WHEEL VERNIER

GREBE RADIO

A Device found only on GREBE Receivers



—for "Hair's breadth" Dial adjustments

"The accomplishment of great things consists in doing small things well."
—Confucius

Perfection of detail is a big factor in the success of the Grebe Receivers.

Doctor Mu

Grebe Regenerative Receivers are licensed under Armstrong U. S. Pat. No. 1,113,149

THE man who has once operated a Grebe Receiver reaches instinctively for the Tangent Wheel Verniers on every other receiver he thereafter tunes.

This and other details of Grebe craftsmanship are fully covered by patents granted and pending. Inspect these details at your dealer's today.

A. H. GREBE & CO., Inc.
Van Wyck Blvd. · Richmond Hill, N. Y.
Western Branch: 451 East 3rd Street, Los Angeles, Cal.

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PAGES WITH THE EDITOR

ONE of the interesting as well as illuminating experiences of an editor's life is to read the letters that come into his sanctum following the publication of each issue of his magazine. Some of the most valuable suggestions for improving POPULAR RADIO have grown out of constructive criticisms in correspondence with readers.

* * *

BUT sometimes the differences of opinion among our readers are so marked—and are expressed with such frank emphasis—that all that the Editor learns from them is that some articles appeal more strongly to one type of fan and other articles appeal more strongly to another type of fan. For instance:

* * *

THE very first letter from a reader to reach us after the April number was issued contained a dig at Don Herold's humorous description of "How I Built a $12.00 Crystal Set, Though 34 Years Old." And the second letter (from L. B. Walton of Kenyon College, Ohio) reported that "the article by Don Herold is delightful." And there we are!

* * *

BUT no differences of opinion on any subject have been more evenly divided than those based upon POPULAR RADIO'S suggestion that the standard left-to-right circuit diagrams be revised to read from right-to-left, in the sequence in which the experimenter builds his set.

"POPULAR RADIO has the right dope. Diagrams drawn from right-to-left are much easier to follow when hooking up your set," votes C. E. Chamberlin, Jr., of Chattanooga, Tenn.

* * *

AND then comes along a satirical protest from A. S. Brown in Norwood, Ohio, who observes; "I am not much on reading diagrams backwards. Perhaps if I could lie on my bed on my back with the diagram pasted on the ceiling I might be able to construct the set all right."

* * *

"I WANT to be the first to thank you for proposing the innovation of showing circuit diagrams to read right-to-left," states E. W. Donnigan of Alden, N. Y. "To me, a novice, it will be most useful."

* * *

ON the other hand. "I am in favor of the schematic drawing as it is," writes Swain Solon of Shenandoah, Iowa. "Why invent a plow that throws the dirt on the left side when it is no better or worse than a plow that throws the dirt on the conventional right side —when both are equally good?"

* * *

THEN, too, there are many fans who take the middle ground and believe, with Herman P. Roth of Olivet, Michigan, that "it makes no difference to me which way the diagrams read."

(Continued on page 6)

Kadel & Herbert

EVEN A BLIND MAN CAN SELL "POPULAR RADIO"

Here is a snapshot of "Blind George" Wittenberg, who runs a newsstand on 42d Street, New York—and listens in at the same time. "I don't keep POPULAR RADIO," *he explains, "I sell it." Here's the proof!*

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In radio the Neutrodyne is the ultimate for selectivity and clear, true reproduction, as well as for power and ease of operation.

THOMPSON NEUTRODYNE

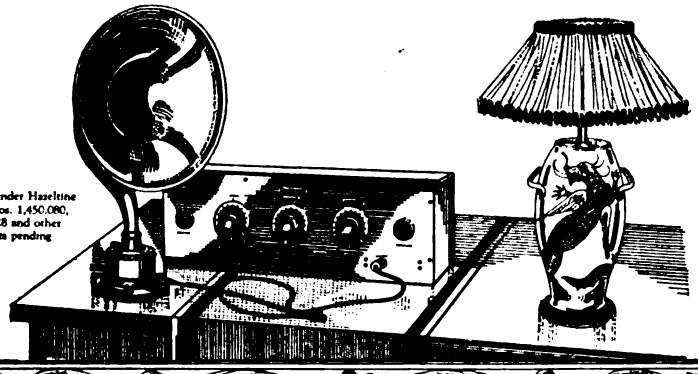
means the best radio principle plus the engineering skill of an organization that has been building radio and wireless apparatus for over fourteen years.

The THOMPSON is a factory-built—not an assembled—5-tube Neutrodyne. What this means to you can be demonstrated by any good dealer. Price $150 without tubes or batteries.

THOMPSON MAGNAPHONE

is built upon an entirely new principle that gives purity of tone in any volume—yet no battery current is needed. The THOMPSON MAGNAPHONE is $35 at all good dealers.

R. E. THOMPSON MANUFACTURING CO.
Manufacturers of Wireless Apparatus for the U. S. Army and Navy and numerous foreign governments
150 NASSAU STREET • • • NEW YORK, N. Y.
FACTORY: JERSEY CITY, N. J.



Licensed under Hazeltine Patent Nos. 1,450,080, 1,489,228 and other patents pending

J.C.

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PAGES WITH THE EDITOR

(*Continued from page* 4)

THE votes of our readers, as recorded up to July 1, 1924, will settle the question so far as POPULAR RADIO is concerned. If *you* have any opinion on the subject—write to the Editor!

* * *

IT was just one year and one month ago that the famous four-circuit tuner (better known as the Cockaday circuit) was first introduced to the radio world in the pages of POPULAR RADIO. Since that time it has been estimated that nearly 600,000 Cockaday sets have been built—and the number is increasing daily.

* * *

SPORADIC attempts have been made by Esteemed but Disgruntled Competitors to belittle Mr. Cockaday's contribution to the radio fan, ranging from charges that the set "radiates" (which it does *not*) to discussion as to whether or not the set is properly termed a "four-circuit." In the meantime the consistently excellent performance of the Cockaday tuner and its steady growth in popularity continues to give ample demonstration that the set is speaking eloquently for itself.

* * *

AGAIN POPULAR RADIO is being featured in the theater! One of the dramatic successes of the season is "The Show Off," in which the misfortunes of a family are finally recouped by the invention of the bright radio-fan member. "Do you know," writes the charming Regina Wallace, who plays one of the leading roles, "that POPULAR RADIO appears on the stage in one of the acts? That's how much we admire it!"

* * *

"YOUR policy of mentioning specific names of parts in your how-to-build articles is commendable, although one can easily understand the objections of some of the manufacturers. But I think you would fail in getting better sets at work and would indirectly harm the industry if you were to listen to the few who kick."

—F. LANDEG, *Hamilton, Ont.*

* * *

OFFICIAL recognition of POPULAR RADIO keeps coming in from new and unexpected quarters—to the gratification of our technical staff. No more convincing tribute to the scientific status of the magazine can be rendered in France than to be quoted in a publication of the high standards of the *Annales des Postes, Télégraphes et Téléphones* which is the official publication of the telegraph and postal service of the French Government. And in the number for February, 1924 (vol. 13, pages 197-208), the editor has printed complete abstracts of two articles from POPULAR RADIO—Prof. J. H. Morecroft's article on modulation in the July, 1923, number, and John Hogan's article on radio regulation in the U. S., from the same number.

* * *

UP in the conservative Nutmeg State POPULAR RADIO has been entering the schools—and is getting good marks from teacher! Mr. A. Johnson of New Britain, Conn., states:

"It may interest you to know of a rather interesting use to which we are putting your magazine here in a local school. In the chemistry class, a great deal of time is taken up in the studying of the theory of ions and electrons. The writer one day brought in to class a copy of POPULAR RADIO during a study of the construction of electrons, in which was a picture of a model of the very atom we were studying, made by a world-famous scientist. We also had a lively discussion of the Einstein theory which your magazine cleared up for us."

* * *

"I CERTAINLY must write and thank you for the service you are rendering the readers of your magazine in keeping advertisements out of the editorial columns, for that is the weak point of some of the other radio magazines."

—BERNARD KALNEETZ, *Philadelphia, Pa.*

* * *

THE recent activities of certain self-appointed censorship organizations with political influence in ruling off the newsstands some periodicals whose doctrines differ from their own, lead one to speculate what might happen to the scientific magazines in case one school of scientific thought should resort to similar tactics to suppress another group!

* * *

SUPPOSE, for example, that the advocates of the Heaviside Layer Theory similarly suppress the utterances of those who do not share their views—or *vice-versa!* Or suppose that one religious sect, through political influence, bans the writings of another sect? Or that the religious sects should unite to ban all scientific writings generally?

* * *

"YOU bring the progressive and truth-seeking public in touch with the best that is to be had in the field of science in general and radio in particular."

—E. KIEFT, *Gary, Indiana*

* * *

"IT may interest you to know that I have the best receiving set in this city. It is a Cockaday four-circuit set as described in your January issue of POPULAR RADIO, and it outperforms any set in town, regardless of cost. We have several of them here and they are all giving perfect satisfaction."

—JULIAN M. SCOTT, *Hannibal, Missouri*

* * *

AND now for the next number—for July—that will contain the second of the series of articles that will tell how to use your receiver during the vacation season. Better ask your newsdealer to reserve your copy *now.*

Kendall Banning

Editor, POPULAR RADIO

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"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"

No. 7111
Eveready
"A" Dry Cell
The best
battery for use
with dry cell
tubes

No. 766
"B" Battery, 22½ volts

More Power for Summer Radio

WHEN you take radio away with you—take Eveready Radio "A" and "B" Batteries, the batteries whose great power lasts longer. Remember, summer's the time when radio signals are weaker.

Batteries do get used up in time. The ones you've been using, though partly exhausted, may be satisfactory for the strong winter signals, but are probably inadequate for the weaker summer signals.

For a "B" Battery use the familiar standard 22½-volt Eveready "B" Battery No. 766. It has variable taps for "soft" detector tubes. Put two, three or four in series to provide sufficient power for amplifying tubes.

To light the filaments of your dry cell vacuum tubes for the longest time, use Eveready Dry Cell Radio "A" Battery No. 7111. The Eveready "A" will astonish you by its long-sustained vigor. It is advisable to use two Eveready "A"s connected in multiple for each WD-11 or WD-12 tube—this gives the "economical eighth" ampere drain per cell which insures maximum economy and longer life. For sets employing one to three UV-199 tubes use three Eveready Dry Cell Radio "A" Batteries No. 7111 connected in series.

The greatest electro-chemical laboratory known created these famous dry cell batteries on which radio largely depends. The experience of thirty years in battery making stands back of them.

Buy Eveready Radio "A," "B" and "C" Batteries—lively, peppy, long-lived producers of power.

For your light-weight sets to take camping or on hikes, Eveready has suitable small batteries.

Manufactured and guaranteed by
NATIONAL CARBON COMPANY, Inc., New York, San Francisco
Headquarters for Radio Battery Information
Canadian National Carbon Co., Limited, Toronto, Ontario

Informative and money-saving booklets on radio batteries sent free on request. If you have any questions regarding radio batteries, write to G. C. Furness, Manager, Radio Division, National Carbon Company, Inc., 128 Thompson Avenue, Long Island City, N. Y.

EVEREADY
Radio Batteries
—they last longer

Please refer to POPULAR RADIO *when answering advertisements.*

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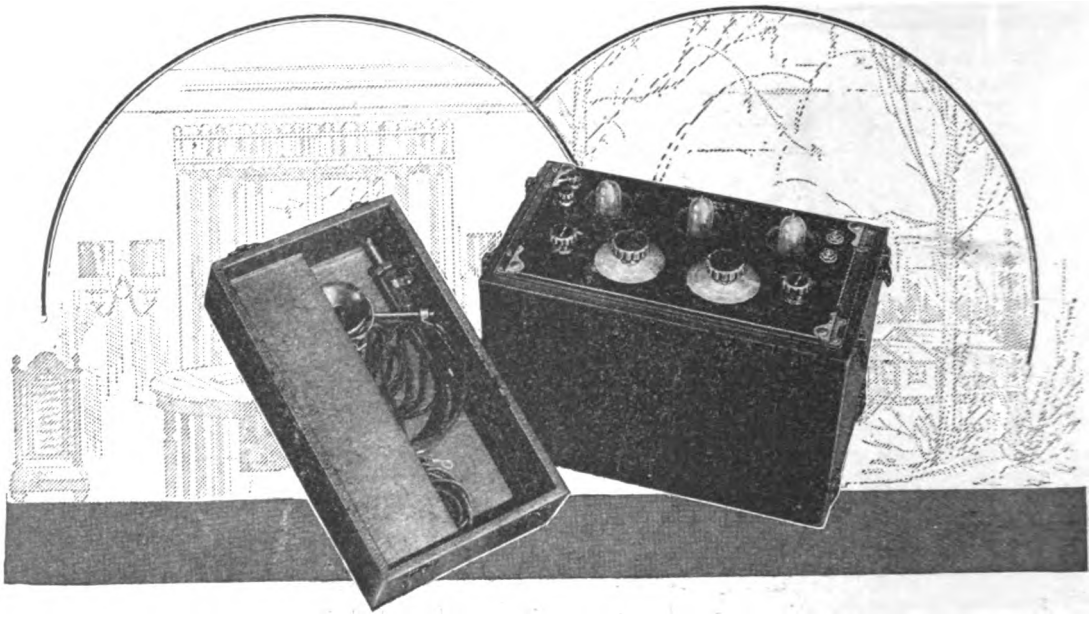

Radio Wherever You Go—New Kennedy Portable Receiver

Here is the famous Kennedy Radio Receiver in a new portable case—a delightful home set that you can take with you wherever you go. In your living room, at camp, by the seashore or touring, this new Kennedy will always give you radio enjoyment at its best. It has a pure musical tone that delights even the most critical—its simplicity of operation makes an instant appeal to every member of the family.

Anyone can operate this new Model III. One station after another can be tuned in *with one single dial.* Each station has its own dial setting, which is always the same no matter where the receiver is located or what type antenna is used. Volume is controlled by the slight movement of a second dial.

The design of Model III is fundamentally correct. Due to exclusive Kennedy engineering developments, it does not radiate—it cannot throw out those howling noises that bother nearby radio listeners and are the cause of the present agitation against radiating receivers.

Price, without accessories, $101.50. ($104.00 west of Rockies.) With Kennedy phones and plug, $111.50. ($114.00 west of Rockies.)

Ask your Kennedy dealer to demonstrate Model III.

All Kennedy Receivers are licensed under Armstrong U. S. Patent No. 1,113,149.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS

MODEL III

Carry it Like a Traveling Bag

A MARVEL of compactness—no larger than a traveling bag. The sturdy cabinet is covered with a grain-seal finished Fabrikoid that makes it an attractive piece of home furniture as well as a practical outdoor set.

Each station has its own dial setting—which never changes, regardless of where you are located or what kind of antenna is used. This is particularly desirable to the summer vacationist, cottager, camper or tourist—as the dial setting outdoors, with a temporary antenna, is the same for any given station as it is in your own living room.

KENNEDY

The Royalty K *of Radio*

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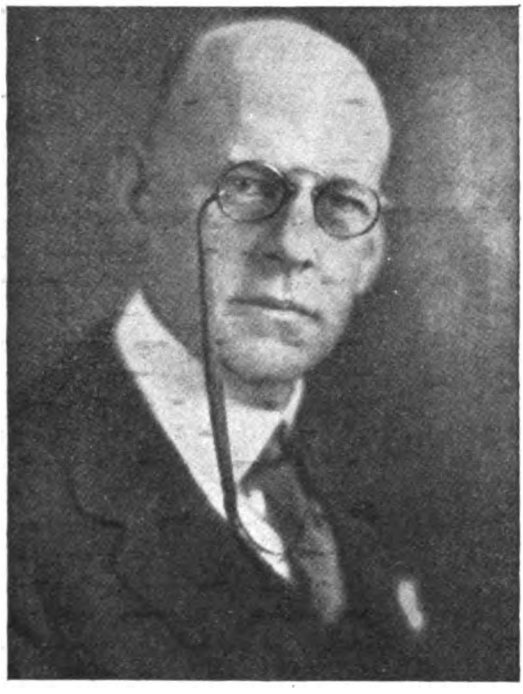

The Unique Position Attained by POPULAR RADIO

"POPULAR RADIO, it seems to me, has more of a place and purpose of its own in the radio field than any of the other radio periodicals which have come to my notice. The success it has attained, it has, in my judgment, faithfully earned through its service to the daily increasing number of those interested in radio matters, and I feel it richly deserves an even wider recognition and success."

—DR. ERNEST FOX NICHOLS,
Director, Nela Research Laboratory.

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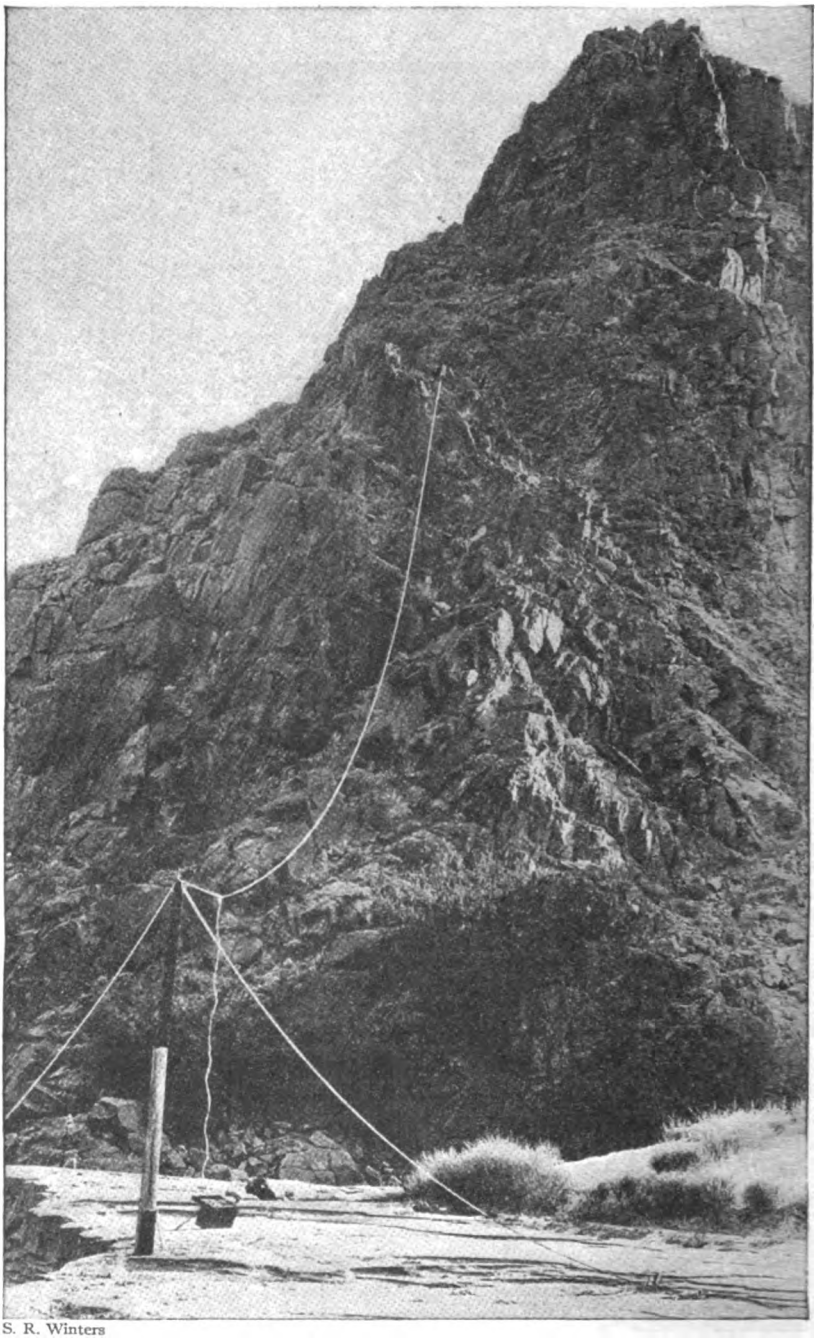

S. R. Winters

An Aerial for the Night

THIS *unique installation is typical of that employed by a group of campers of the U. S. Geological Survey in the Grand Canyon, who moved their headquarters daily during a three months' expedition. The set was a small regenerative receiver; the far end of the antenna wire was attached to a high rock, and the waters of the stream were used for a ground.*

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Popular Radio

VOLUME V JUNE, 1924 NUMBER 6

How to Install a Receiver on Your Boat

During the past year or two radio amateurs have learned a great deal from practical experience with radio equipment on pleasure craft. Before you start work to install a set on *your* boat this summer, read this article by—

LAURENCE M. COCKADAY, R. E.

A YEAR ago at this time people who were interested in radio began to wonder what they would do with their receiving sets during the summer. Should they take their sets with them to the country? Would the static (which they had heard so much about) interfere with reception so that the sets would be useless? Could they take their apparatus to camp with them? Could they take them on their boats for cruising trips? And, most important, would the sets work on improvised antennas? If not, what kind of a set *would* work?

Since last spring, however, there has been such rapid development of radio apparatus and the field for radio receiving sets has been so widened that there are now numerous receivers on the market for all purposes. Instead of receivers that had to be installed in houses and which had to be operated with a regular full-sized antenna and good grounds, there are now sets that give satisfactory results with short pieces of wire for antennas. There are other receivers with the antennas built into the set, out of the way and invisible. And there are sets that work on the ground alone.

Development has proceeded so rapidly that we have really efficient portable receivers that are self-contained in a suitcase with batteries, loudspeaker, loop antenna and all. At last, radio is ready for our use this summer—and we should take advantage of the enjoyment it offers when we are resting up and lolling around on a vacation, whether it be on a boat for a fishing trip or in a snug summer cottage tucked away in the hills, touring in an automobile or just merely tramping the country on two legs.

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In this article is considered the installation of radio on pleasure boats of different sizes. For this is the time of year when the boats must have repairs made, and it is much easier to lay out the radio installation at the same time and have the carpenter put in any shelves or do such other work as may be necessary while he is on the job. In the next article we will take up the other phases of summer-time radio.

Pacific & Atlantic

RIGGING A "PERMANENT" AERIAL

The mast of a small boat serves admirably as an antenna mast. A small portable set that operates on a loop antenna is, however, more convenient for small craft.

Have you a bungalow up the river, or on the shore of a mountain lake? Then, most probably, you also own or have the use of a canoe, or a rowboat, or maybe a twelve or twenty-foot motor boat. Would it not be a pleasure to lie out in midstream of an evening listening to the strains of a famous orchestra or jazz band? Wouldn't your friends enjoy it? And how about the news of the day? You wouldn't have to trudge back to town for a newspaper; just light your pipe and tune in!

When putting radio on such a craft it would be foolish to try to put up a regular antenna installation. All you need in this case is a portable set—a set that you can carry on board when you start out, and can cover with a tarpaulin if the water is rough or if a storm comes up; a set that you can leave in the boat house, take out on the beach or on the lawn or set going in the bungalow at night. In other words, what you need is a set that will work anywhere—a set with a loop, self-contained batteries (preferably dry batteries) and either a separate loudspeaker or one built into the set.

Don't try to make a permanent installation on such a craft, as it will be a nuisance, will be in the way and won't work satisfactorily at best. Buy a ready-made portable set, ready to work anywhere.*

When you put up such a set on a launch or small boat be careful that it is placed in a position where it will get the least wetting. Water will short-circuit the transformers and other instruments if it gets inside the cabinet, and the operation of the set will be impaired.

Take along replacement batteries and a spare tube or two; except for these no accessories will be needed. Just set up the receiver anywhere you happen to be and listen.

* Some of the ready-made sets that are suitable for this purpose are: De Forest Portable, Westburr Six, Sleeper Monotrol, Bristol Portable, Operadio, Melco, and several other radio-frequency receivers.

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Underwood & Underwood

A GOOD TYPE OF RECEIVER FOR A SMALL BOAT

No large overhead antenna is required for a portable set and no connection is needed to the ground. The set pictured here, although it is of the loop type, is too bulky to be practical for a canoe; the loudspeaker and loop should really be incorporated in the cabinet.

The receiving range of these sets varies from 100 to 1,500 miles at night, depending upon atmospheric and other conditions. Daytime ranges are much smaller.

On a motor boat a radio receiver is almost indispensable in summer-time. Such a craft ranges in size from 25 to 60 feet in length and has a cabin and sleeping quarters for two to eight people. While on a cruise in such a boat you *can't* get newspapers; there are periods when the time drags heavily: every one at times gets bored and irritable. Sometimes the engine goes dead, repairs have to be made and conversation lags. This is a logical place and use for radio broadcast reception. With its aid you can keep in touch with the weather man—and this alone is worth while when making a decision as to whether or not to make a try for a more distant port before a storm breaks. The radio will keep you posted for heavy weather; it will also help to while away the time in good weather.

For putting in a radio installation on such a craft there are three courses that may be followed:

First; You may put in a self-contained portable receiver, complete:

Second; You may install a ship-shape antenna and put in a regular standard receiver.

Third; You may install a regular antenna and build and install a receiver.

The first course is the simplest, as the set may be moved from place to place on the boat as desired. The installation requires nothing more than the equipment that has been mentioned previously for use on small craft; merely

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carry aboard a portable set (of a recommended type) and use it.

There are some fans, however, who want to have a more pretentious installation. In such a case the boat should be equipped with two short dummy masts about 12 feet high and a flat-top antenna of the inverted L type installed. Such an antenna system is pictured in Figure 1. The exact way to run the wires is shown in Figure 2.

You will notice that the three wires consist really of one piece strung back and forth between the insulators. The lead-in is carried to the deck from the middle wire, which extends aft to the rear spreader, crosses over to the outside end of the spreader, then back for'ard to the first spreader again. The same wire then crosses over to the other end of the for'ard spreader (after being carefully insulated from the lead-in wire by two insulators), and continues on to the aft spreader again on the other outside end, where it is insulated by another insulator.

The two masts should be placed as far for'ard and aft as possible, so as to get the greatest length of antenna. This distance should not be less than 25 feet for good results; the longer the better.

The lead-in wire should be taken in through the deck by means of a deck insulator placed in a position where it will not be in the way or be stumbled over.

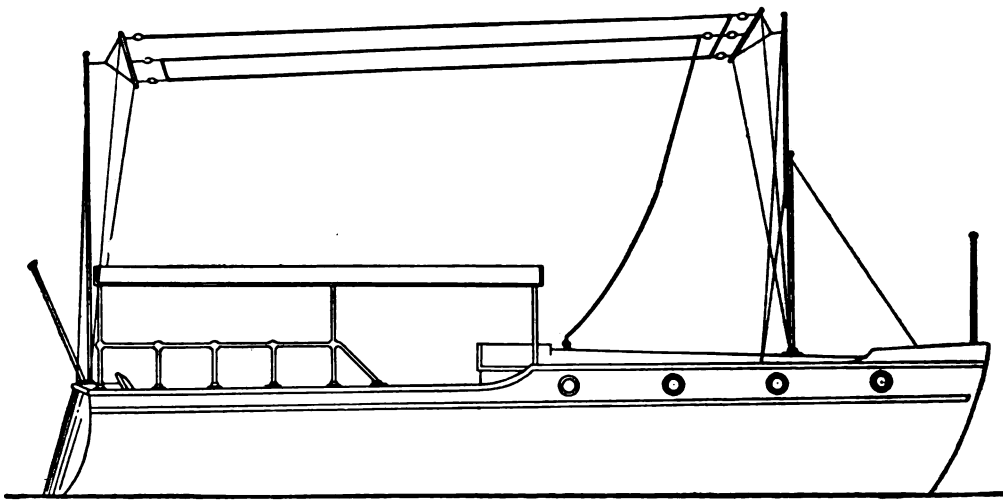
The deck insulator has a metal rod running through it with a binding post on each end. One end is placed outside the cabin and the other end is inserted through the deck and is attached to the antenna post of the receiving set with a piece of wire.

A shelf should be installed inside the cabin, out of the way, for the receiving set, with another shelf located directly below it to hold the batteries.

For a "ground," a wire may be run to the engine base, where it can be soldered on. (See Figure 3.) Or it may be fastened to a copper plate on the outside of the hull.

The set used with this antenna and ground system, can be any of a number of makes that are designed for use with short antennas.*

* Some suitable receiving sets for this purpose are: Grebe, Atwater-Kent (radio-frequency), Melco. De Forest, Murad, Radiodyne, Tuska (superdyne), and several other radio-frequency receivers.



THE BEST ANTENNA SYSTEM FOR A MOTOR BOAT

FIGURE 1: *This diagram shows in detail how to put up a receiving antenna on a cruiser type of motor boat. Notice that the antenna is run in a single length in order to obtain the greatest inductance possible in such a short span.*

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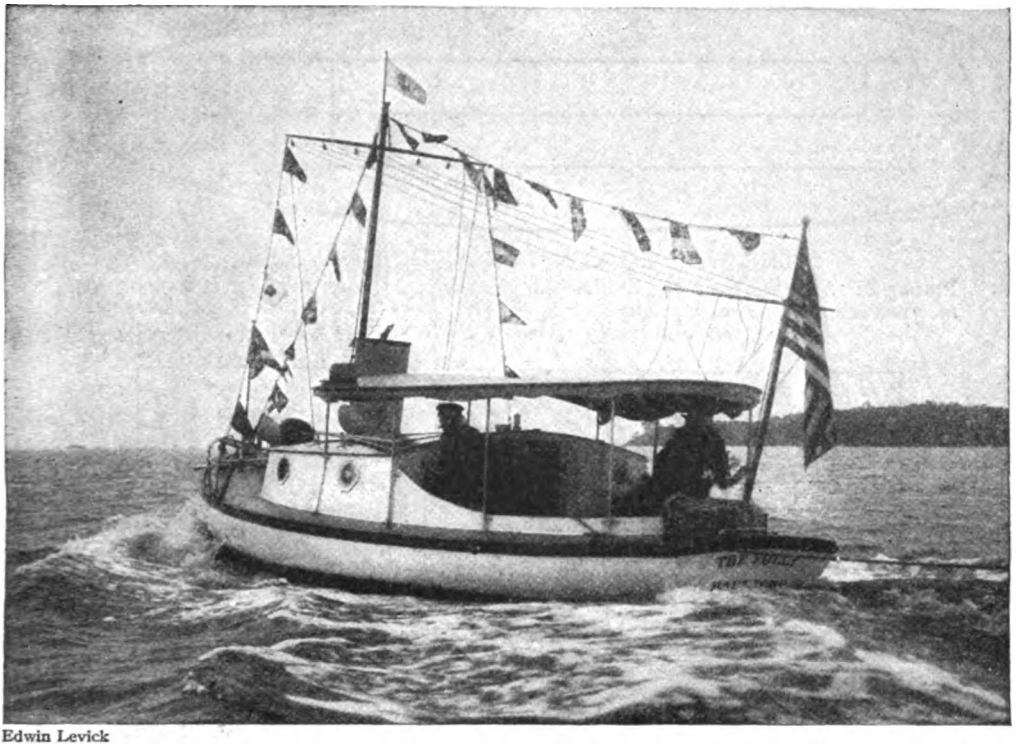

Edwin Levick

AN EFFICIENT FIVE-WIRE ANTENNA INSTALLED ON A CRUISER

This type of antenna should give satisfactory results when connected to any good regenerative receiver or to a good radio-frequency receiver.

If the antenna is thirty feet long or more, any good three-tube regenerative receiver or any five-tube radio-frequency receiver may be used with good results.

For those who want to build both the antenna system and the set, we recommend that the constructional articles in this magazine be followed.*

For boats in which a thirty-volt lighting system is employed, three cells (6 volts) of the storage battery may be tapped off for lighting the filaments of the tubes. This will eliminate the extra storage battery for the set.

On larger sailing boats (50-footers and up), the metal shrouds may be connected together electrically with copper wire (soldered) and a lead brought down to the set. This serves as an antenna and gives good results. * Otherwise a loop set would be best to use.

The ground, on this type of vessel, should be made by fastening on to the hull (below the water-line) a rectangular piece of copper sheet, with *copper* nails. This plate, thus formed, is connected to the set by soldering to a copper strip run up above the water-line and fastened snugly to the ship's sides by copper nails. (See Figure 4.)

Of course, if the sailing vessel has an auxiliary gas engine the ground may be made, as on a motor cruiser, by connecting to the motor casting.

* See "How to Build a Tuned-radio-frequency Receiver," August, 1923, page 132; "How to Build a Non-regenerative Tuned-radio-frequency Receiver," April, 1924, page 378; "How to Build a Regenerative Receiver for Use with a Short Antenna," in this issue. "How to Build the Improved 4-Circuit Tuner," January, 1924, page 23.

* The "shrouds" are the stranded-steel ropes that are used to brace the masts. They run (usually two on a side) from a point a few feet above the water-line up to a short distance from the top of the masts, and, when used as an antenna, eliminate any other wires which would be in the way on a sailing vessel.

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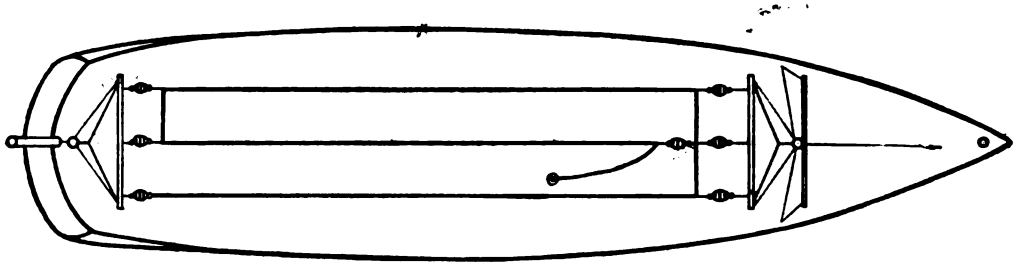
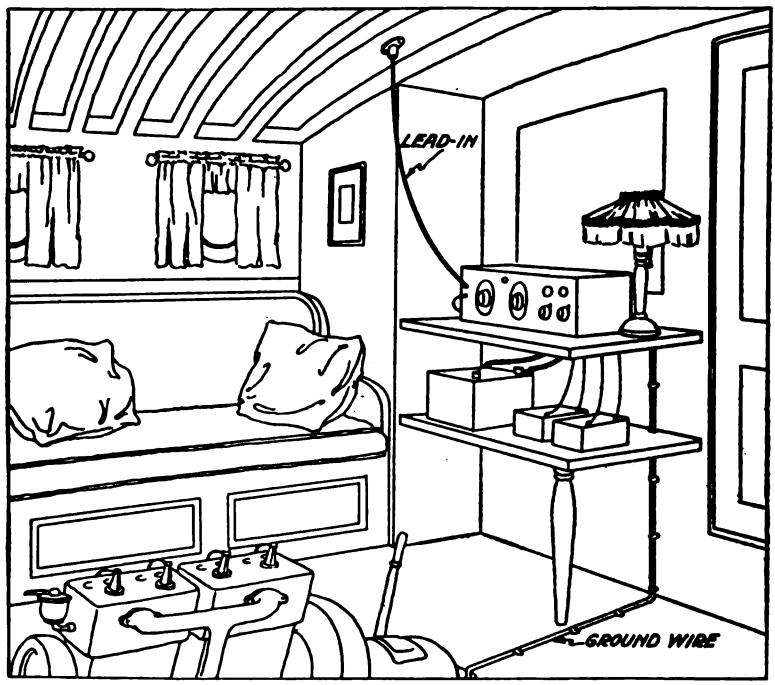


THE WAY TO RUN THE ANTENNA WIRES

FIGURE 2: *Starting from the insulator at the lower left end, the wire is brought to the forward spreader, across and back to the rear spreader, and then down the center to the forward spreader, where the lead-in is taken off.*



A GOOD LAYOUT FOR A RECEIVING SET IN THE CABIN

FIGURE 3: *Showing how the shelves can be arranged and how the antenna and ground wires may be run to the set.*

On any kind of larger craft, 75 feet or over, with two masts, a regular installation of a three or four-wire antenna is recommended with almost any kind of set using upwards of three tubes. Any set that gives satisfactory results at home on a land antenna and ground system, will give much better results on a yacht or vessel of this size.*

On this type of vessel, the distance from the part of the cabin where the set is located to the after deck may be considerable; accordingly it would be advisable to have wiring run beneath the deck boarding with a plug for the loudspeaker at the point where it is desired. It may be possible that there would be two or even three places where it would be desirable to run these leads for connecting the loudspeaker, and the various locations used for plugging in

* Some sets suitable for this purpose are: neutrodynes, reflex sets, any type of regenerative receivers, radio-frequency sets, or if a high-class loop set is preferred, the super-heterodyne.

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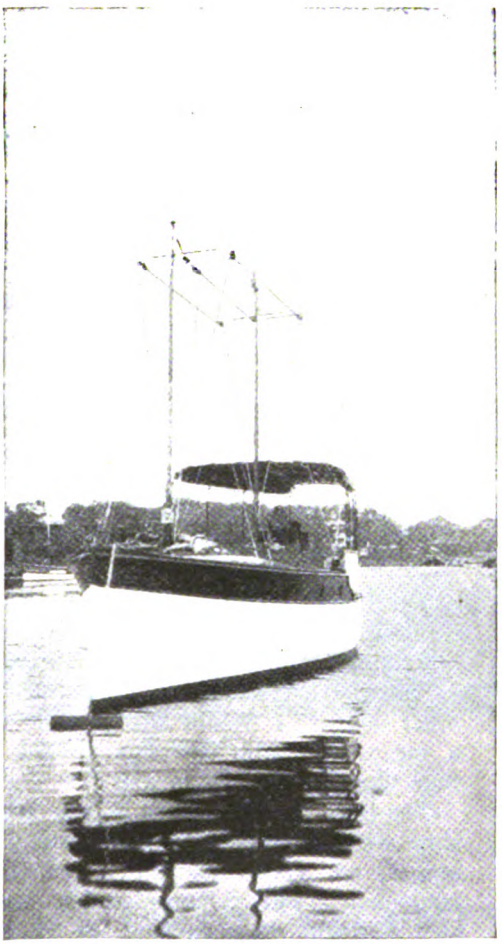
one or more loudspeakers. Tuning, in this case, would be done in the cabin with the headphones, and the loudspeaker lines would be plugged in when the desired station was correctly tuned in.

A simple layout for such a system is shown in Figure 5.

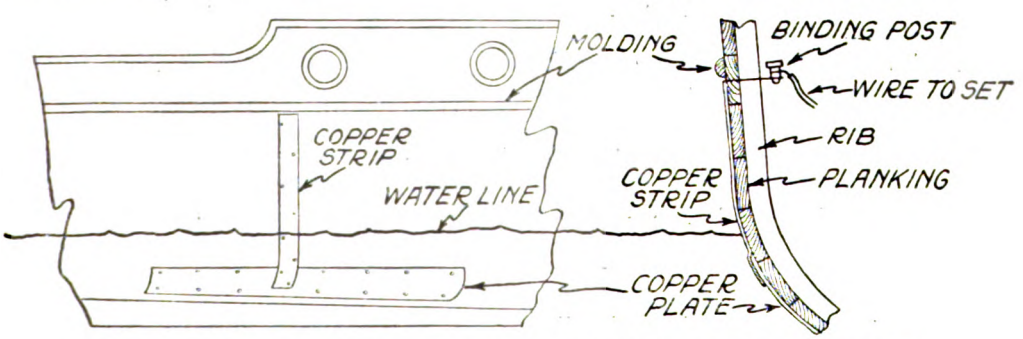
This covers the installation of radio broadcast receiving apparatus on pleasure craft for entertainment purposes.

There is also another phase of the radio situation for small craft that has as yet been given small consideration. There are on land thousands of radio amateurs who use both radio receiving and transmitting sets for pleasure and experimental purposes. Why cannot we have the same kind of license for our pleasure craft, where no commercial exchange of messages would be permitted? This practice would not interfere with commercial radio traffic and it would not interfere with the commercial radio interests' financial returns as at the present time there is no way in which messages may be sent from small pleasure craft and, therefore, no such traffic. If such licenses could be granted, every small pleasure craft could be fitted out with radio transmitting and receiving apparatus (providing the owner or operator could pass the ordinary license examinations), and the stations thus licensed could work on amateur wavelengths; they would really *be* amateur stations just as if they were ashore.



AN IDEAL ANTENNA FOR A SMALL CRUISER

This illustration shows how the antenna arrangements shown in Figures 1 and 2 can be applied to any cruiser.



HOW TO INSTALL THE GROUND PLATE AND COPPER STRIP

FIGURE 4: *These drawings show the manner of fixing a ground plate on the outside of the hull, and how to run the copper connecting strip through the planking into the cabin.*

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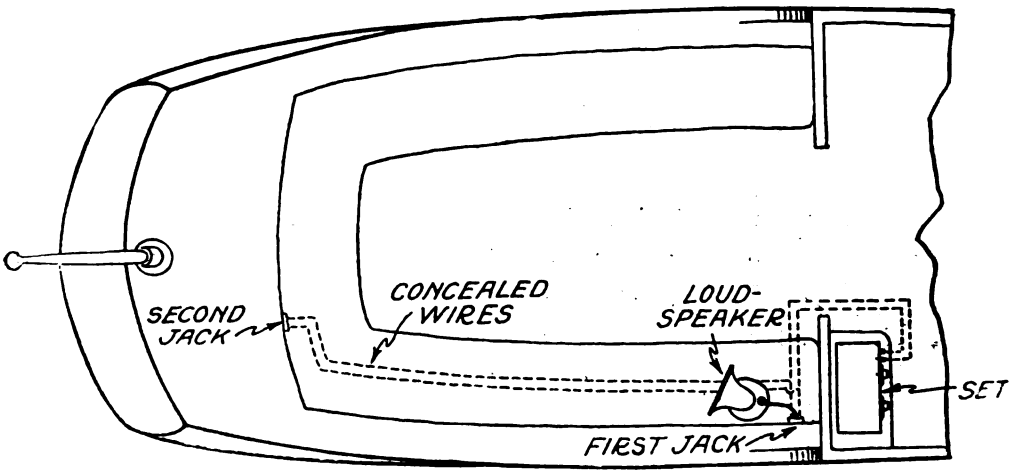

FIGURE 5: *This sketch gives an idea of the plan for running the wires for the loud-speaker to different portions of the deck, so that the music and entertainment can be had where it is desired, without having to move the set around.*

This would permit all pleasure craft, if desired, to be equipped for transmitting to shore or to other small craft, in case of accident, or in case of any other danger; it would also provide for a means of radio direction finding if they were lost at sea in a fog.

The laws of the country require every ship with a specified number of passengers and crew aboard to carry radio equipment. This is considered a necessity for the safeguarding of human life at sea. But during the summer months the waters jeopardize many thousands of lives which could be safeguarded by radio apparatus aboard the smaller craft that carry only up to twenty passengers.

And think, also, what a convenience it would be to be able to call the boat house or the yacht club to advise them of your coming and to order a refreshing supper after a long trip in the burning sun! In this same way arrangements for staying over at a seaside resort could be made, and business men could be kept in touch with land through the home yacht club. Indeed, at the present time there are a number of the larger and more progressive yacht clubs which have radio sections or divisions that are becoming alive to the possibilities of radio and radio broadcasting as an adjunct to the sport of yachting. Some of these clubs have even gone so far as to install transmitting apparatus on the club house, and in a few cases the clubs have cooperated with the owners of boats to help them with their installations.

This is the time of year when the members of yacht clubs should get radio sections started, so that fans will be able to get some of the advantages out of radio as applied to their own boats. Now is the time to start the radio ball rolling—before the season gets too far advanced.

¶ *Every radio fan who lives in town knows what annoyance can be caused by* PREVENTABLE *interference in broadcast reception. How to locate the causes and what you can do about them when you find them will be described in* POPULAR RADIO—*for July.*

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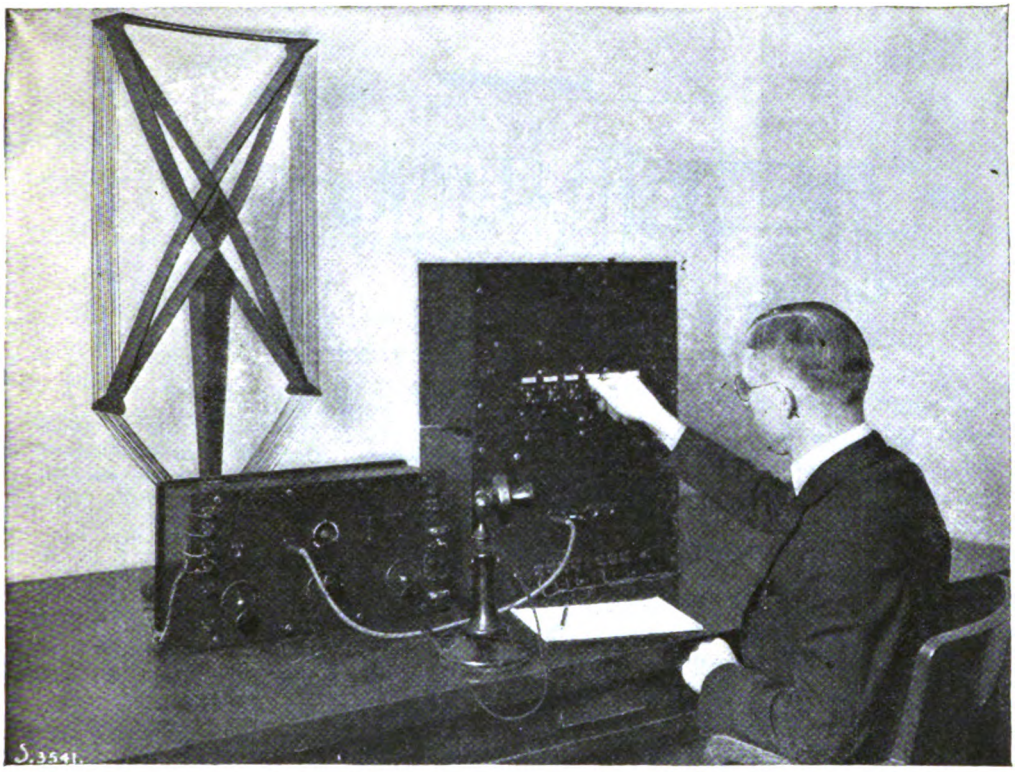

"CALLING" A SHIP AT SEA BY RADIO

FIGURE 1: *By merely setting a little switch the apparatus selects the receiving station that is "wanted on the radio" and rings a bell in the same manner as in the regular line telephone. Such a system makes possible the assigning of a telephone number to a ship, so that it might be called from a land station, as a wired station is.*

"Please Give Me the LEVIATHAN!"

Here is a new invention that enables a radio transmitting station to "call" some particular receiving station by ringing a bell to attract the operator's attention—a device that will vastly simplify communication with vessels.

By R. W. KING

SINCE the advent of radio it has been the dream of the inventor to devise a means of signaling a given station by a ringing bell as is done in wire telephony. Such a scheme would, in many cases, make it unnecessary to have an operator in attendance at all times and would add greatly to the economy and the convenience of operation.

The inventor's dream has been realized. It did not come as the result of long research directed toward that end, but instead it followed from results incidental to other researches.

The radio telephone is destined to find a big application in communication

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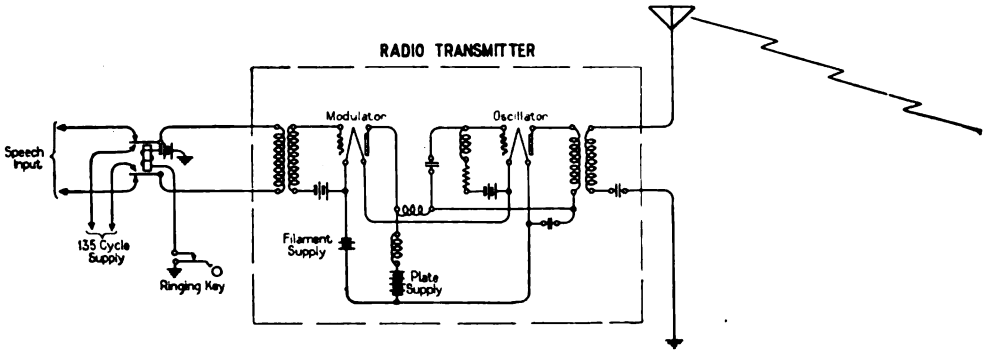

HOW THE CALL-SYSTEM WORKS

FIGURE 2: *This diagram shows, schematically, how a special signal is sent out from the transmitter (above) and is picked up by all receivers. Only the particular receiver which is "set" for this signal will respond, however, and the bell will ring only at that particular station. A diagram of the receiver is shown on the opposite page.*

with moving objects such as ships, where wire telephony is not applicable.

The new signaling scheme is obviously a big contribution to such a service, for it enables any transmitting station, properly equipped, to signal any one of about seventy-five other stations in the same system without calling the remaining stations. The attention required by the receiving set, then, is little more than caring for an ordinary telephone.

The means whereby this was accomplished have been perfected by C. S. Demarest and M. L. Almquist of the American Telephone and Telegraph Company and L. W. Clement of the Western Electric Company. The apparatus, which can be incorporated as a part of practically any radio system, enables a calling party, by simply turning a key, to call any other party in the system.

The photograph reproduced as Figure 1 pictures an operator in the act of "placing" a call.

When a station is to be called, a code, produced by modulating the radio transmitter currents by a 135-cycle alternating current, is sent out on a specified wavelength. This is received by all stations that are tuned for this wavelength, but only that radio receiver which is set for this particular code will so operate as to ring the local annunciator bell. The ringing code may be likened to a key which in this case is applied simultaneously to several locks, only one of which will be unlocked and opened.

In Figure 2 is shown a simplified diagram of the circuit used. The ringing key causes the 135-cycle current to be impressed on the transmitter instead of the ordinary voice currents. This key determines the code to be sent.

Figures 3A and 3B show the nature of the direct current that flows through the key and also the 135-cycle alternating current impressed on the transmitter corresponding to the code 8-5-4. At all of the receiving stations this is passed through the detectors and amplifiers in the same manner as ordinary speech signals. The resulting current is like that of Figure 3B. This operates the 135-cycle relay and its accompanying direct-current relays so as to produce a series of impulses like that shown in Figure 3C. This alternating-current relay is remarkable in that it will respond to currents as low as .00025 ampere, providing they are of a frequency of 135 cycles, but it is practically unaffected by all the higher frequencies used in transmitting speech or spurious currents such as those resulting from static. A selector located at each station is so constructed that it is operated only by the particular code for which it is set.

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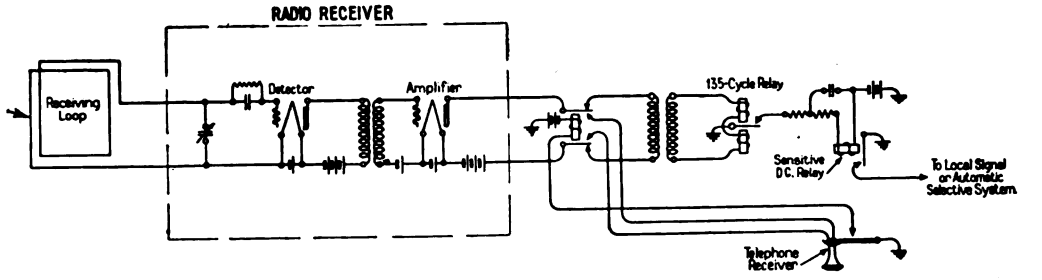
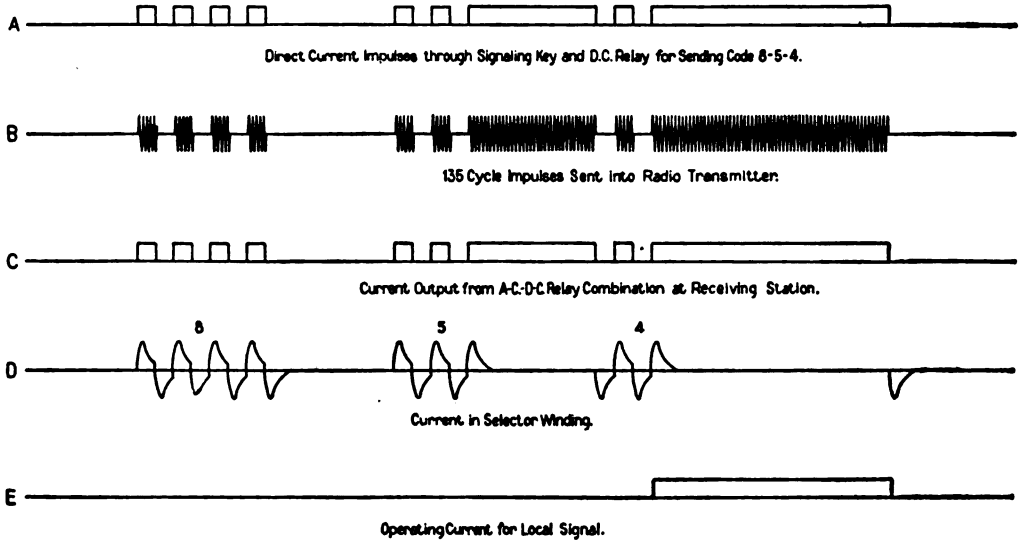


In Figure 4 is shown the signaling equipment as an adjunct to standard radio apparatus. The lower cabinet at the left encloses the relays, selector and other apparatus on which the signals are received while in the upper cabinet is the apparatus used in calling.

This development is a remarkable example of the cumulative value of research. The different pieces of apparatus involved were developed for other purposes, without any thought as to their possible application to radio. The 135-cycle relay was designed for a system of low-current telegraphy used in conjunction with telephone circuits. The selector and the code sending key came from the standard circuits used for train dispatching while the relays are standard parts of telephone equipment. Had this development been attempted by people outside of the telephone laboratories many new problems would have been encountered, but by combining the experience gained by years of research in both radio and wire telephony, the development followed naturally.

In a test of this signaling system it was shown to be particularly free from interference from outside sources. It



A VARIETY OF "SIGNALING CURRENTS"

FIGURE 3: *Here are some of the graphs of the signaling currents that flow in the various circuits in the transmitter and the receivers. These currents are the "open sesame" for the station that is being called, as they set the relays and ringing apparatus into operation.*

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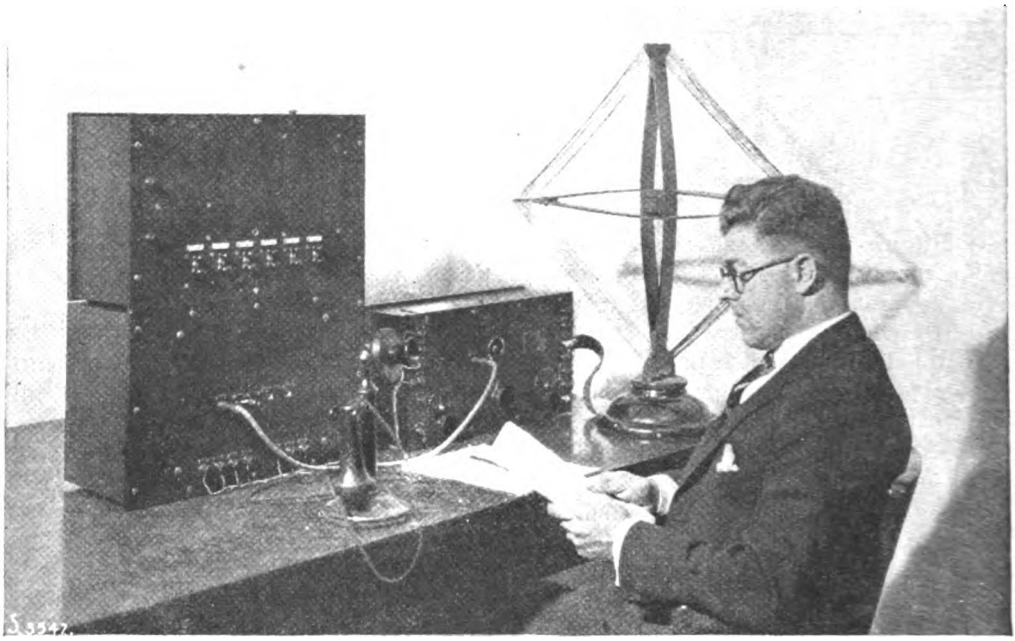

THE SHIP'S OPERATOR NEED NOT "LISTEN IN" FOR HIS CALL

FIGURE 4: *The operator merely sits and reads or otherwise occupies himself until the radio-telephone call bell rings. He can, of course, listen at any time he wishes—but this is no longer necessary.*

was found that the signaling system would continue to function correctly when the interference was many times that which would make conversation impossible. While Figure 2, for simplicity, shows a circuit arranged for one-way speech, it has been developed for two-way conversation.

How to Build Your Own Portable Receiver

IN the next issue of this magazine—for July—will be published, for the first time, full and complete details for the construction of the POPULAR RADIO PORTABLE RECEIVER. This is a small, compact 6-tube radio receiving set that operates on a small loop antenna and that can be carried about on your business trips, vacation travels, motor tours, cruises or off into camp as conveniently as an ordinary suitcase is carried. This set, which has been created in the laboratory of POPULAR RADIO, marks a distinct step forward in the development of the small portable receiver—and it may be built by any amateur who has only an ordinary proficiency with tools at a cost for parts not in excess of $100.00, exclusive of tubes, batteries and telephones.

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Scientists Tell Us That Within a Year—

1. RADIO *relay systems will be extended so that the same program can be broadcast simultaneously all over the United States—and perhaps in Europe as well.*
2. THE *election of presidents will turn largely on speeches that are broadcast over the whole country.*
3. A SYSTEM *will be adopted by which inter-denominational religious services will be broadcast to the whole country every Sunday.*
4. A RADIO *record will be perfected so that programs can be received automatically all day—and run off later when desired.*
5. THE *first broadcasting of pictures by radio television on a commercial basis may occur, and a "picture receiver" simple enough to be built by amateurs may be announced.*
6. A NEW *circuit that eliminates static will be perfected.*
7. AMATEUR *transmission will be carried on more and more on the short waves, and long distance transmission will be attained on from 20 to 50 meters.*
8. APPARATUS *for the production of directed beams of radio waves will be announced for the use of amateurs as well as for the purpose of relaying broadcast programs.*
9. THE *waves sent out from living nerves will be detected by radio apparatus—thus opening up a whole new field of scientific work in physiology and psychology.*
10. THE *theory of the crystal detector will be discovered and new crystals of great sensitivity will be produced.*
11. TRANSOCEANIC *amateur tests will be extended to Asia, Africa and South America.*
12. EXPLORATION *of the upper air will yield new facts about the Heaviside Layer and a new theory of fading and of long-distance transmission.*
13. A SINGLE-TUBE *receiver capable of operating a loudspeaker on a loop antenna and having less distortion and greater volume than any present multi-tube receiver, will be developed.*

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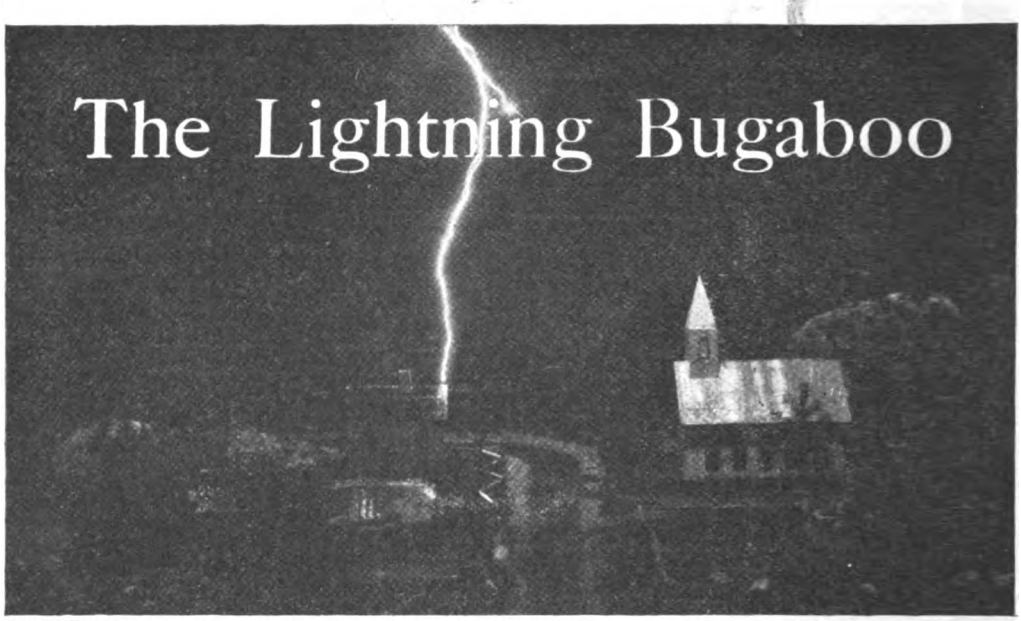
The Lightning Bugaboo



General Electric

A radio antenna creates absolutely no danger from lightning. On the contrary, an antenna may be an actual protection against a bolt striking your house as it allows a part of the atmospheric electricity to leak away slowly and harmlessly. The author of this article—who was formerly president of the Institute of Radio Engineers—has had years of experience both with lightning and with antennas—and he has never seen an antenna struck by lightning!

By ROBERT HENRY MARRIOTT

SOME people are afraid to have radio receivers because they imagine that lightning will strike their antenna and kill them.

I imagined that too—twenty-five years ago. But experience in radio changed my mind.

Indeed, my former instructor in physics, Dr. B. F. Thomas, at Ohio State University, said he believed that time might prove radio antennas to be a protection against lightning, because the antennas might serve as a gradual leak for the electricity in the neighboring atmosphere and keep it from being built up to the danger point. My practical experiences have confirmed his belief. You might say that a lightning cloud is like a snowball picking up charges as it rolls along, until it breaks of its own weight. If your antenna has already picked up all of the charges in your neighborhood, nothing will be added in your neighborhood to cause the break.

Some of my experiences with lightning and antenna in various parts of the United States and Alaska and on ships have been interesting and exciting, but none of them have been injurious to me. For instance:

In 1901, I was on a ship that was not equipped with radio when a wooden mast was struck by lightning. Since then I have had to do with the radio on perhaps three thousand ships, commercial

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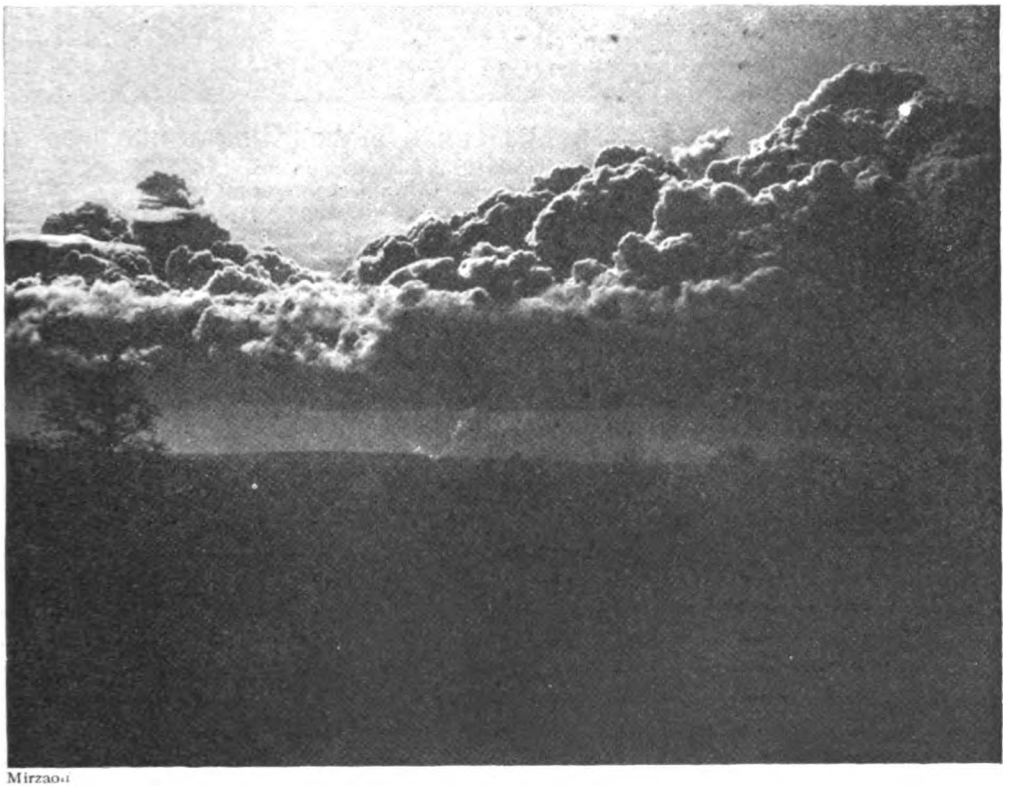
ships under many flags and navy ships. To the best of my knowledge, none of their antennas were ever struck by lightning.

In 1905 one of the stations I was building was at Altman, Colorado, about two miles above sea level. Violent rain and lightning were quite regular there, as at other places along the top of the Rocky Mountains, on summer afternoons. To the observer at Altman the lightning appears to be striking in a circle around him because he is so high above the surrounding country and can see so many miles in all directions. One afternoon the lightning was so unusually violent that I thought maybe it would be just as well to leave the radio station and make my observations from the window of the saloon about fifty feet away, from which position I could see into the radio station.

When the lightning flashed near-by I tried to count the seconds until I heard the sound. This was to estimate the distance. (You know that light travels almost instantly and sound travels only about a thousand feet a second.)

Some flashes and reports were too close together for me to count a second and two or three flashes and reports seemed to occur almost at the same instant. After one of those close ones, the transformer house across the street from the radio station began to smoke like an old-fashioned meat house. It was the power company's transformer burning up. Yet with all of that lightning the radio antenna apparently was entirely untouched.



Mirzaoff

WHERE ELECTRIC CHARGES GATHER TO MAKE LIGHTNING

Masses of cloud act as collectors of atmospheric electricity; finally the charge becomes so great that a spark passes from the cloud to the earth. That is lightning. A wire raised into the clouds will bring down electricity almost any time, as it did in the famous experiment of Benjamin Franklin with his kite.

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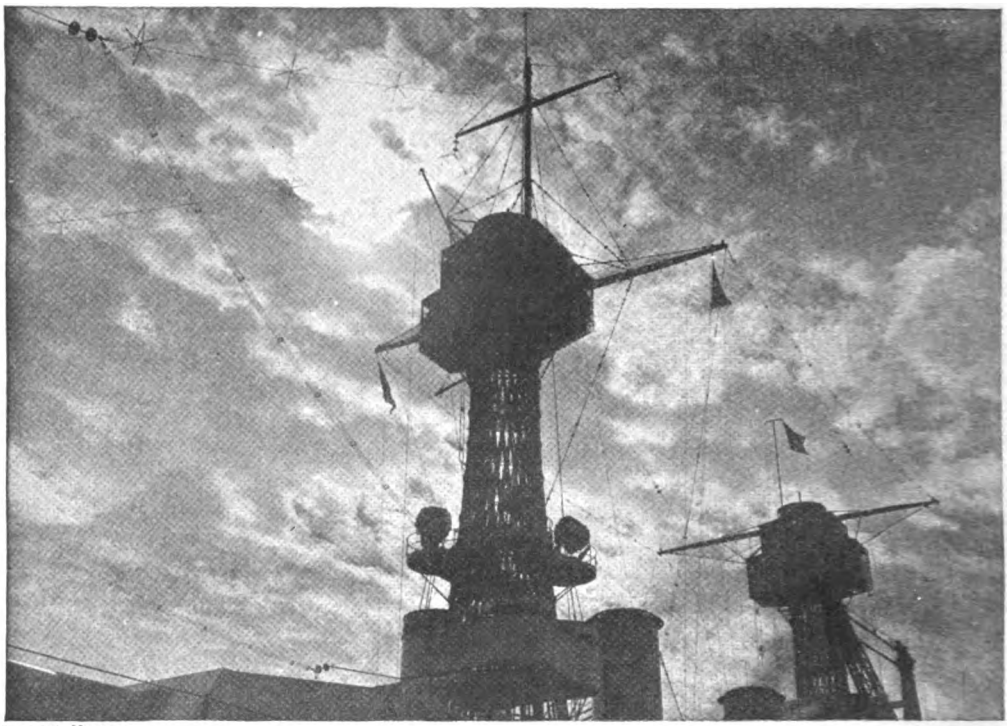

Kadel & Herbert

"NO SHIP'S ANTENNA HAS EVER BEEN STRUCK BY LIGHTNING"

This, says the author, has been his experience in a long acquaintance with radio at sea. The antenna wires serve as a path through which electric charges on the ship can leak away instead of accumulating to the danger point.

The same year at Pueblo, Colorado, I was within five feet of an antenna that was two hundred feet high, when lightning struck a wooden house that was about a quarter of a mile from the wireless station and only about fifteen feet high.

Reports of lightning striking antennas have been numerous, but on investigation the evidence indicated that the reports emanated from induction or direct discharge from the wireless station's own transmitters, or induction from lightning (static) or sometimes only the imagination.

One of the odd cases occurred at the Altman Colorado station. Naturally the radio operators thought that if lightning would strike an antenna at any place, it would be at Altman. And an operator did abandon that station and came in to Denver and reported that lightning had struck the antenna and burned up his receiving tuner. On investigating the station, however, I found that he had shifted the antenna around to another position. How he made the shift without getting killed I do not know, unless it was because the 2,300-volt power line he pulled it over happened to be better insulated where the antenna touched it at the time than where the antenna touched it later. For, later a guy wire stretched and let the antenna sag so that it touched the power line, and in this way electric power went through the antenna and thence through the receiving tuner until the tuner windings burned up and made a gap in that electrical path to ground.

Making contact with light and power wires is something to look out for. It is not good practice to put an antenna over or under any power or lighting

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wires. If the receiver circuit is a metallic circuit to ground, almost any low or high-power circuit would burn it up if the antenna made contact with the power wire.

Do not fear being killed by lightning *via* a radio antenna. However, you should have a so-called "lightning arrester" on your antenna for quite other reasons.

The so-called lightning arrester for radio antennas probably should be called a "by-pass for static," because that is probably its chief use. Under some conditions static can cause a fire or destroy the sensitiveness of a detector or give a shock that might conceivably cause a very old or very nervous person to die from fright. I naturally would not take hold of an antenna wire when there was a thunderstorm overhead.

On the Atlantic Coast, in Texas and mountain regions I have used antennas of about the same kind and gotten daily static discharges to ground of about one-sixteenth of an inch for many hours of the day, and longer discharges for shorter periods. On the Pacific Coast from Southern California to Alaska there is much less static. For about ten days in August in one place in Alaska, we were unable to detect any static at all. In the United States static is strongest along the Rockies; next strongest along the Atlantic Coast and weakest along the Pacific.

A wire two hundred feet high apparently gives nearly a two-inch discharge to ground at any place in the vicinity of a thunderstorm. And the small broadcast receiving antenna might discharge a half inch to ground and in doing so might jump through cotton insulation that was very dry and cause a little fire. Or the static might jump in a way that would carry over a short-circuiting current from filament batteries or "B" batteries or battery-charging arrangements, and the electric power from batteries and power lines can burn up wires or insulation and cause a fire. The lightning arrester should prevent such results from static.

Static is usually induced from lightning or from smaller electrical discharges occurring at some place else. Sometimes static is direct discharges from the atmosphere. Fogs, snow, dust, smoke and steam often discharge to antennas and cause little sparks from the antenna to ground, if there is a gap in the circuit. Those discharges to the antenna are miniature parts of lightning from which real lightning is built up when the charge-carrying atmosphere contracts into a cloud having an outside surface much smaller than the total of all of the surfaces of the little particles.

When a thunderstorm is approaching the static induced in the antenna is capable of jumping farther and farther to ground. As the storm moves away the distance the spark will jump gets smaller. People have occasionally been hit by such static while handling the antenna side of their receivers and have said they were "nearly knocked down by lightning." When a person says that he was "knocked down by electricity" it probably means that he jerked away so quickly that he lost his balance and fell over. An electrical condition that could actually pick a man up and slam him down would probably nearly burn him up.

I have received numerous static shocks from antenna. Some of the sparks that have hit me were probably two inches long. None were the least injurious.

I have sampled the effects of big and little lightning and big and little antennas over the United States without injury to myself. And as it did not hurt me, I do not believe it will hurt anybody else.

¶ *What is "resistance" in radio? What is "inductance"? What is "capacity"? These questions will be answered in terms that the beginner can understand in a new series of articles in* POPULAR RADIO.

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From a photograph made for POPULAR RADIO

Why the Broadcast Listener Should Not Be Taxed

An opinion on the broadcasting problem by one of the world's foremost scientists

IF the broadcasting situation is let alone it will settle itself on economic grounds and far better than any laws can settle it. For what will happen is this:

As soon as sales of radio apparatus begin to fall off so that the manufacturer will not bear the expense of broadcasting so easily, the manufacturers will get out more highly selective apparatus and broadcasting will be carried on somewhat after the method of sending and receiving by the "Yale lock" method (U. S. patent 715,203, which expired December, 1919) or some one of half a dozen other methods. This, in turn, will create a new market for receiving apparatus. When this market is filled, the manufacturers will get out apparatus which will give good results only from their own broadcasting stations when their particular types of apparatus are used.

In like manner the new markets will be developed one after the other, and each may be sold to saturation before the next is taken up. In some respects it will develop just like the automobile business; no one would use a 1905 machine today if he got it for nothing.

Leaving the present situation alone will result, too, in immense improvement in broadcasting and wireless generally. It must be remembered that the fact that America is so far ahead of other nations in wireless *is due entirely and solely to the radio amateurs.* The fact that they were not hampered by dozens of laws (and they deserve great credit for blocking off all the mischievous legislation that has been proposed) allowed them to get in on the game; they are the ones who built up the market and provided the incentive to commercial broadcasting.

It may be objected that if there is no regulation and taxation all amateurs can listen in. Let them; they are entitled to all consideration, and when they get money enough they will be the best customers for the latest type of receiving apparatus.

If the broadcasting companies insist on taxation and rentals they will not only kill their business but will set back radio development for thirty years.

Still another reason for leaving the situation alone is that we have altogether too many paid government officials now. We shall soon be in the position of those islanders "who gained a precarious livelihood by taking in each other's washing." And this phase of the problem is no joke. Each government official has a family of (say) three others beside himself to be supported by taxes. Consider the percentage of government officials in your own community; if it is six percent, multiply that by four; then reflect that when four men sit round a lunch table, three of them are supporting the fourth and his family in order that he may tell them what they must not do. If you take into consideration the actual figures and not the six percent that I have assumed, you will be surprised.

So for all these reasons I believe the matter should be left to settle itself naturally on economic grounds. In fact it would have settled itself long ago but for officious meddling.

Reginald A. Fessenden.

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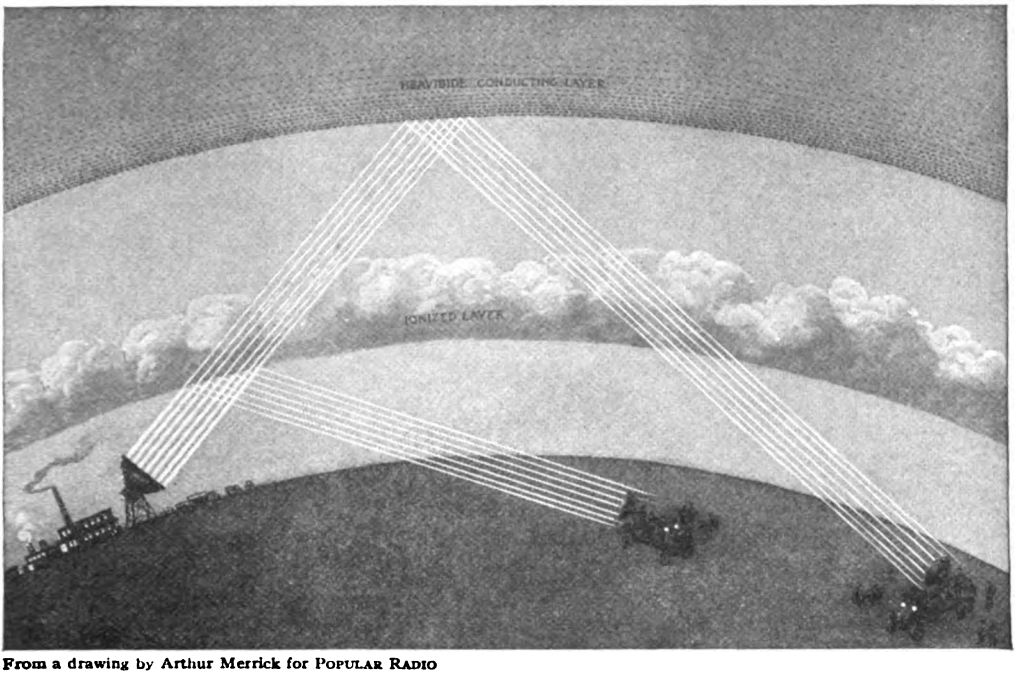

From a drawing by Arthur Merrick for POPULAR RADIO

HOW EXPLORERS MAY SEARCH FOR SECRETS OF THE UPPER AIR

Very short radio waves may be used soon to study the conditions in the inaccessible regions of the earth's atmosphere. Beams will be reflected more or less completely from conducting layers and may be detected and measured by portable receiving outfits equipped with condensing parabolic reflectors.

How Short-Wave Radio May Help the Weather Man

High up in the air there exists a mysterious something that radio engineers call the Heaviside Layer. Weather men suspect that this same region of the atmosphere may have much to do with thunderstorms and other weather changes. One way that scientists foresee to study this upper part of the air is by directed beams of very short radio waves. Waves less than two meters long have been used for telephony by General Ferrié and Commandant Mesny of the French Army. This article tells how these new "radio ripples" will prove useful in scientific work.

By E. E. FREE, Ph.D.

ALTHOUGH the use of shorter and shorter waves has been so pronounced a feature of recent advances in radio science, it has usually been considered impossible to reduce the length of useful waves much below 100 meters.

This is not because the shorter waves are unobtainable. As long ago as 1917 Gutton produced continuous waves 1½ meters long by means of vacuum tubes. A little later Barkhausen and Kurz* succeeded in producing waves only ½

*"The Shortest Waves Producible with Vacuum Tubes," by H. Barkhausen and K. Kurz, *Physikalische Zeitschrift* (Leipzig), vol. 21, pages 1-6 (January, 1920).

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meter long. On the other hand Dunmore† in the United States and Franklin‡ in England have studied standing waves of short wavelength and have obtained good results down to waves only three meters in length. Among the damped waves, short wavelengths have been realized for some time, including waves like those used in the original experiments of Hertz and, more recently, the waves produced by the American physicists Dr. E. F. Nichols and Dr. J. D. Tear§, waves measured in centimeters and millimeters and which constitute the shortest radio waves so far produced by man.

But the experiments with waves as short as 1½ meters, while of the greatest scientific importance, did not provide for the practical use of such unusually short waves in radio communication. The amount of power emitted by the transmitter was too small. Signals were not readable in a receiving apparatus located at any considerable distance from the transmitter.

A number of research laboratories, both here and abroad are working actively on this problem of short-wave radio and it is violating no confidence to say that the results already are most promising. Modified tubes are necessary and the experimenter is compelled, also, to give careful consideration to even the smallest details in the design of his circuits. The time necessary for electrons to move through a wire or through space for a distance even so small as a hundredth of an inch becomes a vital factor of the problem when frequencies that approach a million kilocycles are under consideration.

Important steps toward the utilization of short waves are embodied in recent experiments carried out under the direction of General Gustave Ferrié and Commandant René Mesny of the French Army.* Practicable transmitting and receiving apparatus has been developed for waves with a length of 1½ meters

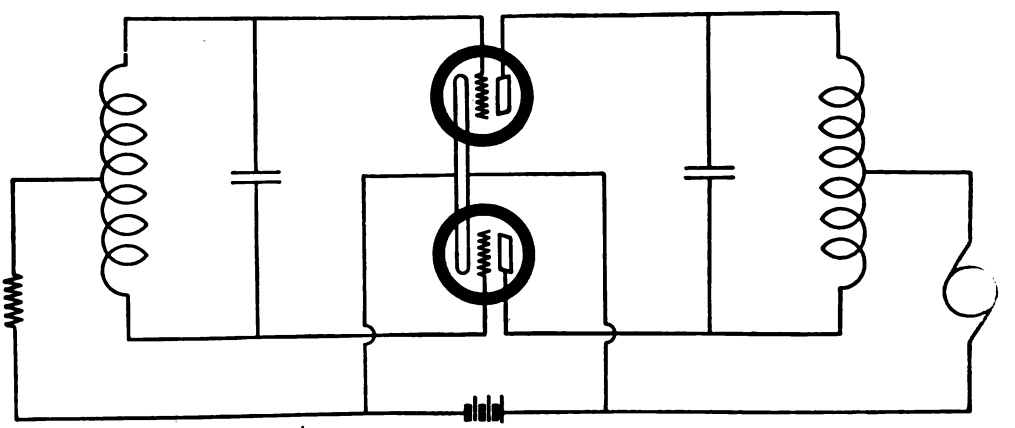
† "Directive Radio Transmission on a Wavelength of Ten Meters," by F. W. Dunmore and F. H. Engel. U. S. Bureau of Standards, Scientific Paper No. 469, April 11, 1923; *also*

Dunmore and Engel, "A Method of Measuring Very Short Radio Wavelengths and Their Use in Frequency Standardization." *Proc. Inst. Radio Engineers*, vol. 11, pages 467-477 (October, 1923).

‡ "Directive Radiotelegraphy with Very Short Waves," by C. S. Franklin. *Wireless World* (London), vol. 10, pages 219-255 (March 20, 1922).

§ "The Shortest Radio Waves Ever Produced by Man," by E. F. Nichols. POPULAR RADIO, vol. 4, pages 22-29 (July, 1923).

* "The Very Short Waves," by René Mesny. *L'Onde Électrique* (Paris), vol. 3, pages 25-37 and 99-110 (January and February, 1924).



Redrawn from a diagram in *L'Onde Électrique* (Paris)

HOW THE TWO TUBES ARE CONNECTED IN COMMANDANT MESNY'S SHORT-WAVE GENERATOR

Note the symmetrical mounting of the two tubes, so that very high-frequency oscillations can be produced. The frequency attainable by this device is limited only by the time necessary for the electron stream to move across the space inside the tubes.

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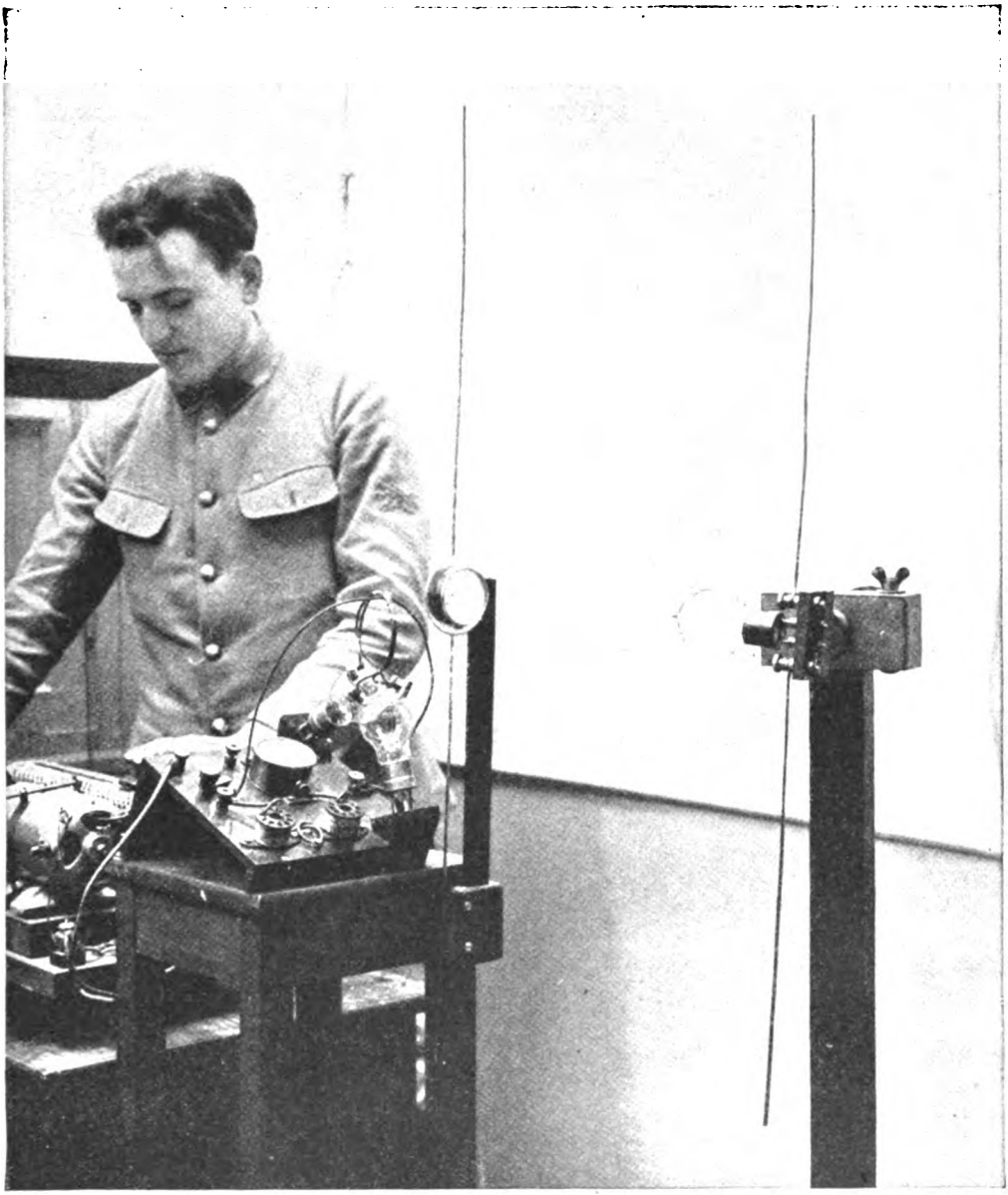

From a photograph loaned by Commandant Mesny

HOW THE 1.5-METER WAVES WERE PRODUCED

The generating apparatus is on the board at the left of the picture. Note the two tubes, the inductances and the condenser box. The first vertical wire (with the ammeter at its center) is the transmitting antenna. The vertical wire at the right contains a detector lamp and serves as the receiving antenna. This is the outfit used in the laboratory experiments by General Ferrié and Commandant Mesny.

(about 5 feet). These very short waves have been used successfully for radio telephony over distanecs up to 2 kilometers (1¼ miles).

In the oscillator used for transmission the usual vacuum tube is replaced by two tubes, mounted symmetrically. The circuits are arranged to reduce as much

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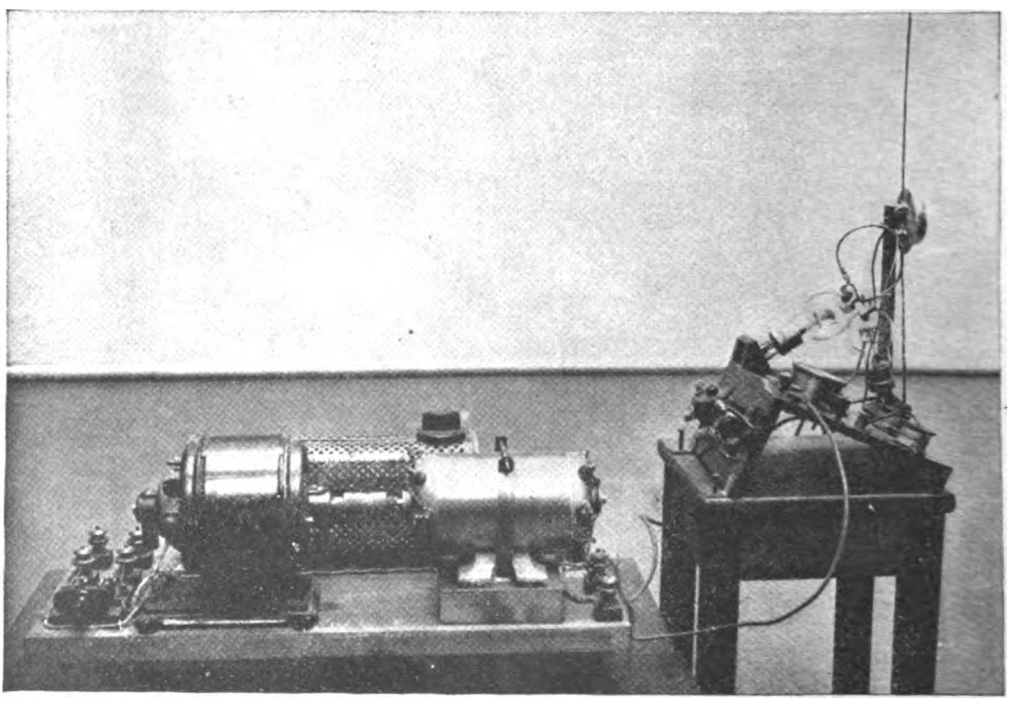
as possible the path which must be followed by the high-frequency oscillations. The generation of high-frequency waves, corresponding to 200,000 kilocycles or more, is thus rendered no more difficult than the generation of waves of ordinary frequencies.

Waves as short as 1.2 meters (250,000 kilocycles) have been obtained successfully, but for the operation of the apparatus in actual radio communication waves of 1.5 meters to 1.6 meters (200,000 to 187,500 kilocycles) have been employed.

The production of waves still shorter than 1.2 meters is theoretically possible, but is limited by the internal construction of the vacuum tubes. The tubes used were a simple modification of those ordinarily employed for radio telephony in the French military service. Their construction is such that the time required for the electrons to pass from the filament to the plate is of the order of one one-hundred-millionth of a second. So soon, therefore, as one reaches frequencies in the neighborhood of 200,000 kilocycles this internal characteristic of the tubes becomes an important factor limiting the operation of the apparatus.

The antenna used is very simple; it is merely a vertical wire the length of which is one half the wavelength that is being used. For example, for a 1.5 meter wave the antenna may be a single wire .75 meter long.

This transmitter, using waves approximately 1.5 meters long, has been used in tests of telephone transmission between two suburbs of the city of Paris at three o'clock in the afternoon with entire success. Even when both the transmitter and the receiver were located in a forest at a distance of 500 meters from each other, transmission was still possible in spite of the absorp-



From a photograph loaned by Commandant Mesny

THE SHORTEST-WAVE BROADCASTING STATION EVER BUILT

This is another view of the transmitting equipment shown on page 549. The power is supplied by the motor generator shown in the foreground. Behind it is the regulating rheostat. At the right is the oscillator itself and the vertical-wire antenna.

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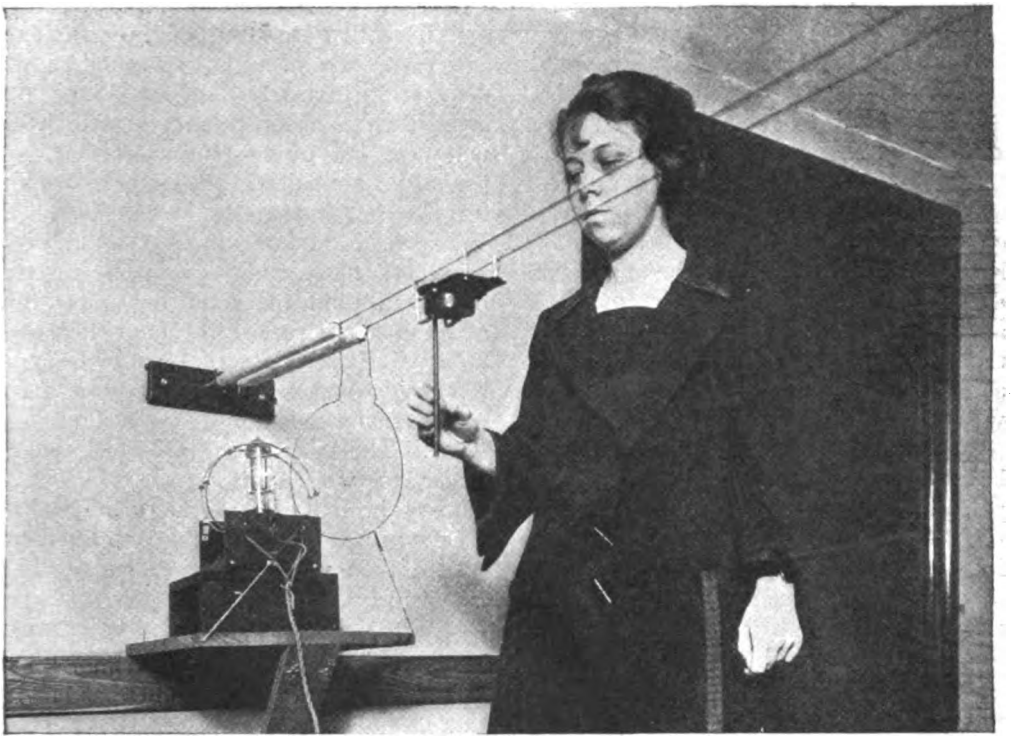

From a photograph made for POPULAR RADIO by Harris & Ewing

AN AMERICAN EXPERT IN SHORT-WAVE RADIO

Miss G. Hazen of the United States Bureau of Standards, who has assisted Mr. Dunmore of that Bureau in his work with waves ten meters long and less, is here shown with the short-wave transmitter used in the Bureau's method of establishing wavelengh standards by means of standing waves on two parallel wires. (This method was described in the issue of POPULAR RADIO *for February, 1924, page 209.)*

tive effects originating from the trees.

This was accomplished, Commandant Mesny reports, with antenna currents in the neighborhood of 80 milliamperes. With larger currents it is probable that the communcation range for apparatus of substantially the same design can be extended to 15 or 20 miles, perhaps much more than this.

The great advantage of these very short waves in radio communication lies in the fact that they may be concentrated with ease into directed beams. The well-known work of Mr. Dunmore and Mr. Engel of the United States Bureau of Standards, using ten-meter waves, has already been referred to and this points the way to what can be done with still shorter waves.

The open air radio-telephone experiments of General Ferrié and Commandant Mesny do not appear to have included any work with such directed beams, but laboratory experiments carried out by them with their 1.5 meter wave transmitter do include some interesting experiments with the reflection of waves from metallic mirrors.

For the conduct of these experiments a short-wave transmitter consisting of a single vertical wire is placed fifteen or twenty feet in front of a metallic screen which serves as a mirror for the waves. Into the space between the transmitter and the mirror there is then introduced another vertical wire, containing a lamp. This wire serves as a reception antenna. With the small distances employed, the current produced in this reception wire is sufficient to make the lamp glow

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whenever the wire is in the proper relation to the system of standing waves in the space between the transmitter and the mirror.

This wire and lamp serve, therefore, as a means of exploring the forms of the original wave and of the reflected wave, just as the human eye serves to explore the behavior of the waves of light. Experiments with the device indicate that the reflection of radio waves and the interference of the reflected and the original wave obey, in this instance at least, much the same laws as do the waves of light.

For the production of concentrated beams the flat metallic mirror is replaced by one that is curved. It is in the form of one side of a cylinder with its axis vertical. Mirrors of parabolic section may be employed as well, as they were in the experiments of Dunmore and Engel.

There is every reason to believe that devices of this kind will serve to give us very soon a much clearer understanding of the nature of radio-wave propagation than we have had hitherto. We will have "radio telescopes" as we now have optical telescopes. We will be able to carry out with radio waves those experiments on interference, on spectral analysis, on polarization and on other phenomena, the investigation of which in the case of light waves has been so useful to the progress of science.

There is, for example, the pressing problem of how radio waves are absorbed by obstacles, such as buildings, trees and mountains. Light waves, we know, are frequently absorbed in definite "absorption bands." A certain wavelength of the light, or a certain group of wavelengths is absorbed and removed from the beam of mixed waves. The other wavelengths that happen to be present are allowed to pass. Materials, as we say, are "transparent" for some wavelengths of light; "opaque" for other wavelengths.

Do radio waves behave in this same way or differently? Do steel buildings for example, absorb *all* radio waves alike or does each particular building have its own definite absorption band which it will take out of the transmitted wave, leaving unimpaired the other wavelengths that happen to be present.

The second of these possibilities seems to most radio engineers nearer the truth than the first, but we must admit that the real truth about it is unknown. Experimentation on such matters using waves in the ordinary range of wavelengths is almost impossibly difficult. The very short waves are much easier to work with. When we can employ beams of half-meter waves as freely as we now use the broadcasting waves, then we may expect to discover the principles that control the relations of radio waves to such objects, just as we now know the principles that regulate the propagation, absorption and bending of light.

We will be able then, to *predict* the absorptions and deviations of the waves from a proposed broadcasting station as accurately, we may hope, as the opticians can now predict the exact characteristics of a lens intended for a camera or a telescope.

But perhaps the most immediate benefit that we may expect from the use of these short waves will be found in the scientific study of the electric properties of the atmosphere. We know from the phenomena of fading, as well as from the considerable deviation of waves that cross a continent, that the atmosphere plays an important role in the propagation of electromagnetic waves. For example, the great distances covered by such waves are attainable only because of the presence in the upper part of the atmosphere of that conducting region that we call the Heaviside Layer.

The availability of the very short waves will permit us, from now on, to multiply our observations on these phenomena of propagation as well as to

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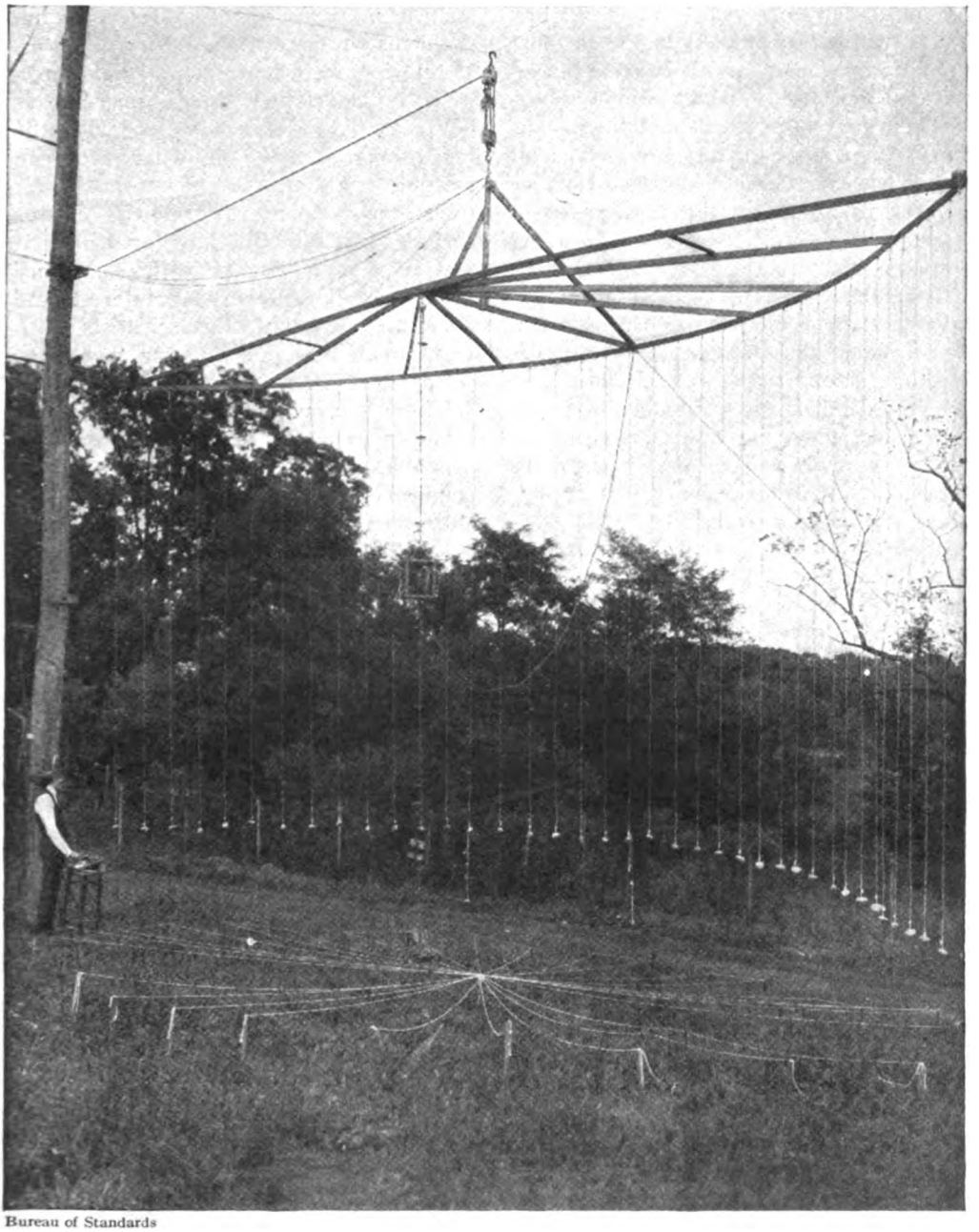

Bureau of Standards

The Ten-meter Reflector of the Bureau of Standards

This reflector was built by Mr. F. W. Dunmore of the Bureau of Standards for his work with directed beams of radio waves ten meters long. The transmitter proper is the small box suspended in front of the wires; the wires themselves are hung from a parabolic support and each wire is tuned separately to exact resonance with the wavelength, the tuning being done by lengthening or shortening the wires. With this reflector Mr. Dunmore was able to direct nearly all the energy of the radio wave in one direction, very little energy passing through the wires.

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organize new observations on fading. There will be required only the installation of a number of short-wave transmitters, the cost of which will be low.

The very short waves will permit us to produce at will directed beams of radio waves. These beams can be pointed upward into the atmosphere at selected stations. Movable receiving stations will permit the determination of the exact places where (if anywhere) these beams return to the earth. From such data, if we know fully the characteristics of the waves themselves, we can deduce much valuable information concerning the materials—ions or electrons or what not—that occupy the layers of our atmosphere which are inaccessible to us directly.

Every radio fan realizes nowadays how important are these upper levels of the air, fifty or sixty miles over our head, to radio transmission. They are important also to the study of earth magnetism, to the theories of atmospheric electricity (including, of course, the theories of the cause of static) and to many other pressing problems of terrestrial physics.

And to take a more familiar example it is probable that these upper levels of the air have much to do with the mysterious causes of what we call weather. The causes of storms, their tracks as they move over the earth's surface, the rain or snow or hail that they drop down on us as they pass, all these matters of everyday interest and importance contain, the scientists confess, much more of mystery than they do of discovered and certain fact.

There is every reason to believe that if we can get more complete and dependable information about the true conditions in the upper levels of our atmosphere we shall be able to take a great step in advance in explaining the weather and, what is of much more practical importance, in predicting it.

Radio science is opening a new chapter in meteorology, a chapter that promises much in the way of scientific discoveries, as well as in applications that are directly practical.

© Western Electric.

PICKING UP AND TAKING DOWN A BROADCAST SPEECH

Students of shorthand are advised by Miss Helen Kearns of Newark, New Jersey, that excellent training may be had by the simple expedient of taking down at home the talks that come in by radio—and that the "varied styles of delivery" assures valuable practice.

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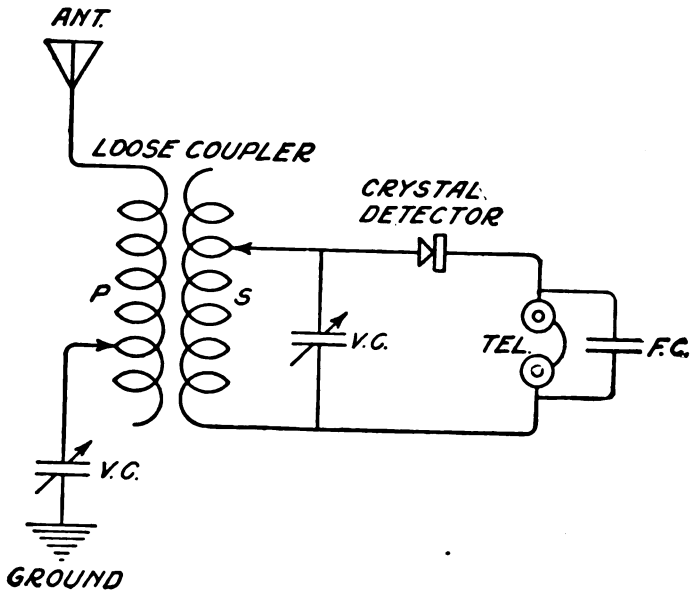

INDUCTIVELY COUPLED CRYSTAL RECEIVER

Cost of parts: Not more than $22.00.
Selectivity: Good.
Operation: Fairly simple.
Construction: The whole set can be constructed on a board and wired up in an hour or two.*
Approximate range: 15 miles.
Outstanding feature: The sharpest tuning crystal receiver that it is possible to make.

*(See POPULAR RADIO, *August, 1922, page 293, for constructional details.)*

100 BEST HOOK-UPS

INSTALLMENT NO. 7

IN this series of hook-ups is being published—for the special benefit of the radio novice who is undecided as to just what circuit he wants—100 of the best radio receiving circuits, each thoroughly tested. The approximate ranges given here are averages based on actual records made with receiving sets throughout the country. During the summer the actual ranges may fall to 50 percent of the value given, while in the winter, in the best of conditions, the actual ranges may exceed the values given by as much as 500 percent. All of these circuits have been described in detail in previous issues of POPULAR RADIO.

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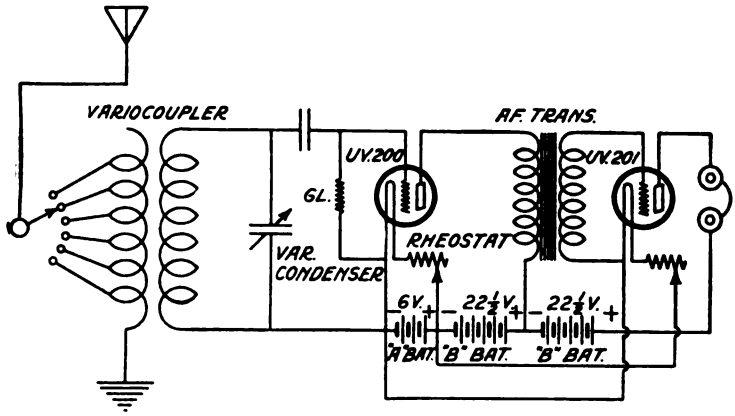
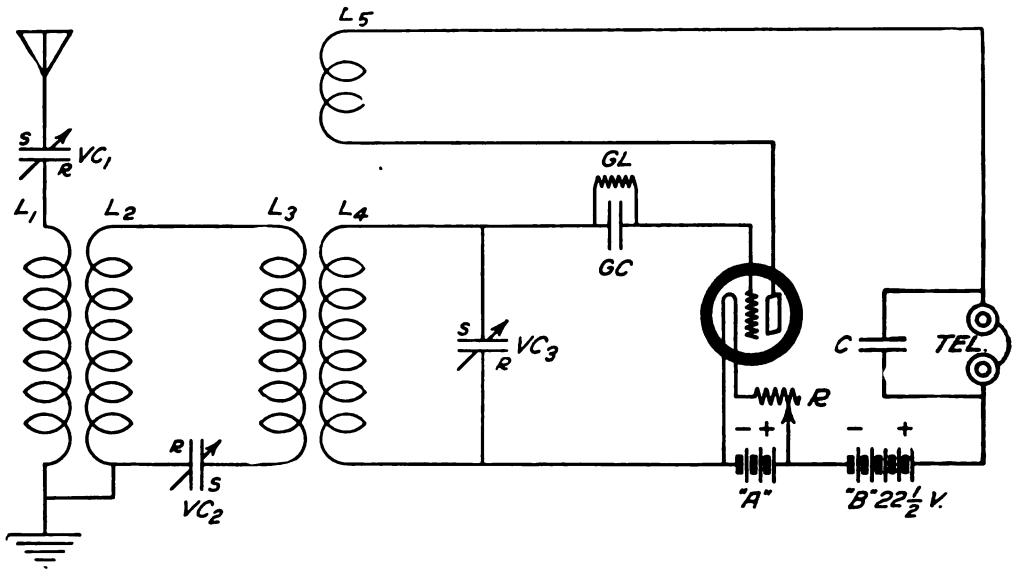


INDUCTIVELY COUPLED, VACUUM-TUBE RECEIVER WITH ONE STAGE OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $28.00.
Selectivity: Fairly good.
Operation: Simple.
Construction: Easy to make.*
Approximate range: About 100 miles.

Outstanding features: The added stage of amplification increases the operating range considerably and makes the local programs more enjoyable for use with a number of headphones.

(See POPULAR RADIO, October, 1922, page 147, for constructional details.)



A REGENERATIVE RECEIVER WITH AN INTERMEDIATE CIRCUIT TO REDUCE RADIATION

Cost of parts: Not more than $30.00.
Selectivity: Very good.
Operation: Rather complicated.
Construction: Just an ordinary acquaintance with tools and some ability in wiring up the electrical circuit is necessary.*
Approximate range: 500 to 1,000 miles.

Outstanding features: The receiving system used here makes use of an intermediate, resonant circuit for loosening the coupling between the antenna circuit and the grid circuit so that radiation will be prevented. The loose coupling employed makes for sharp tuning.

(See POPULAR RADIO, March, 1924, page 292, for constructional details.)

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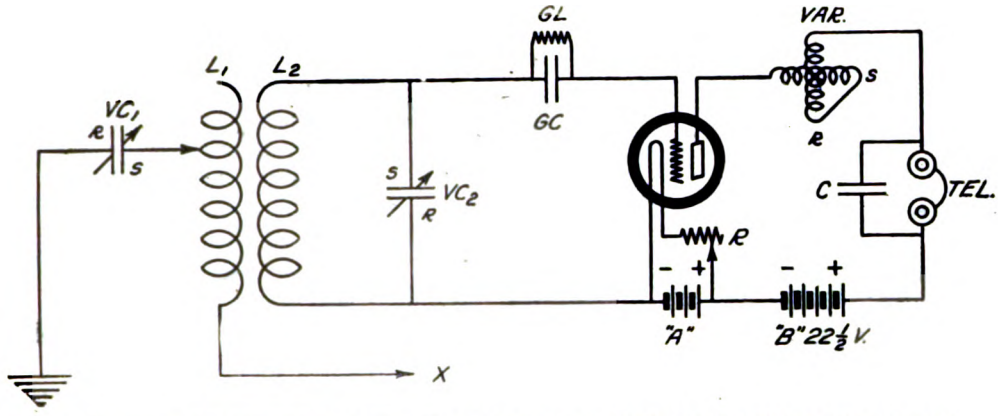
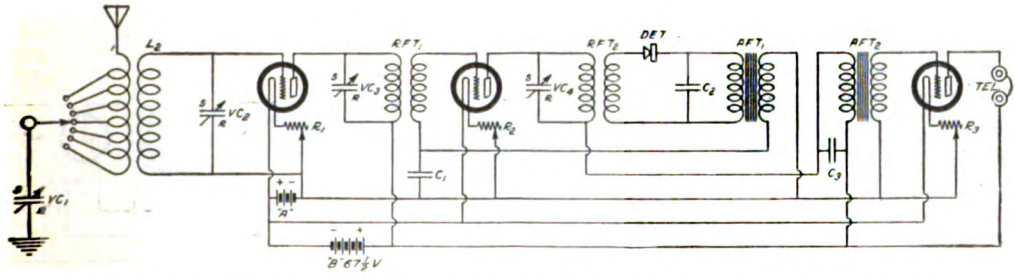


A SIMPLE REGENERATIVE RECEIVER FOR USE WITH TWO GROUNDS

Cost of parts: Not more than $30.00.
Selectivity: Excellent.
Operation: Not especially complicated. The ground circuit is tuned by means of a variable condenser; likewise the secondary circuit. The plate circuit of the detector tube is tuned by means of a variometer and this controls regeneration.
Construction: Not complicated.*
Approximate range: Local.
Outstanding feature: No antenna is necessary. Just use two grounds; one may be the water pipe and the other the radiator system or the gas pipes.

(See POPULAR RADIO, November, 1923, page 373, for constructional details.)



TWO STAGES OF TUNED-RADIO-FREQUENCY AMPLIFICATION, CRYSTAL DETECTOR AND TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $60.00.
Selectivity: Very good. Tuning is accomplished entirely by means of variable condensers.
Operation: Rather complicated. The tuning should be done by logging the settings for the various wavelengths.
Construction: Not a simple set to make. Some experience in making sets should be had before attempting construction.*
Approximate range: 2,500 miles.
Outstanding features: Only three tubes are used. One stage of audio-frequency amplification is reflexed.

(See POPULAR RADIO, January, 1924, pages 80-81, for constructional details.)

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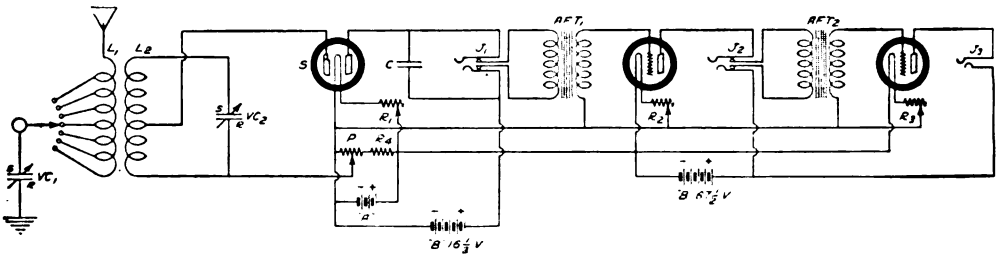
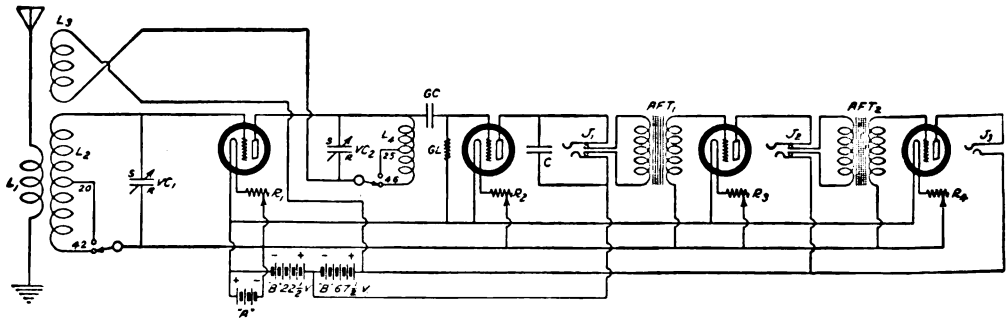


DONLE DETECTOR CIRCUIT WITH TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $38.00.
Selectivity: Fair.
Operation: Very simple.
Construction: Not hard to put together.*
Approximate range: 1,000 miles.
Outstanding feature: This circuit uses the new type of sodion tube which is extremely sensitive but which cannot oscillate or radiate.

(See POPULAR RADIO, March, 1924, pages 294-295, for constructional details.)



THE SUPERDYNE CIRCUIT WHICH EMPLOYS A REVERSED-TICKLER FEED-BACK FOR ELIMINATING REGENERATION

Cost of parts: Not more than $47.00.
Selectivity: Excellent.
Operation: Rather complicated. The operator will have to get used to the proper adjustment of the tickler before he will get good results, but when this has been learned, the set will function nicely.
Construction: Fairly complicated.*
Approximate range: 2,000 miles.
Outstanding features: Excellent selectivity and sensitivity.

(See POPULAR RADIO, March, 1924, pages 296-297, for constructional details.)

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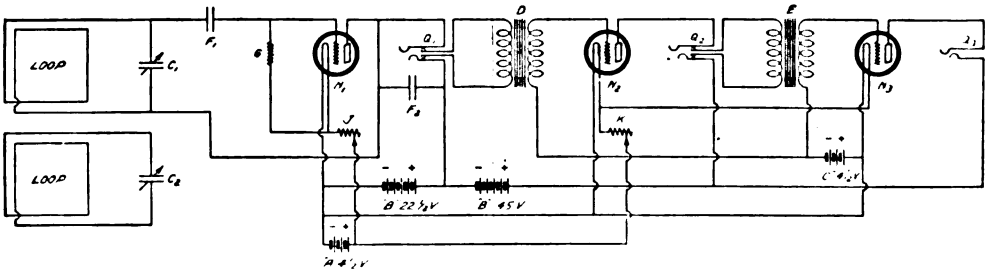
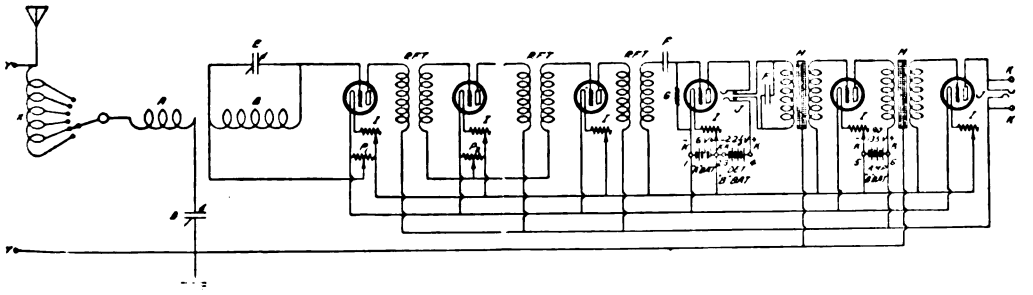


FOUR-CIRCUIT PORTABLE RECEIVER

Cost of parts: Not more than $50.00.
Selectivity: Excellent.
Operation: Simple.
Construction: Not difficult.*
Approximate range: Local.
Outstanding feature: All parts mounted in a cabinet, including loops, batteries and tubes.

*(See POPULAR RADIO, *February, 1924, page 152, for constructional details.)*



THE DX CIRCUIT WITH THREE STAGES OF RADIO, DETECTOR AND TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $60.00.
Selectivity: Very good.
Operation: Fairly simple.
Construction: Complicated.*
Approximate range: 2,500 miles.
Outstanding feature: The addition of the radio-frequency amplification to the original DX set improves the sensitivity greatly without complicating the tuning control.

*(See POPULAR RADIO, *April, 1923, pages 310-311, for constructional details.)*

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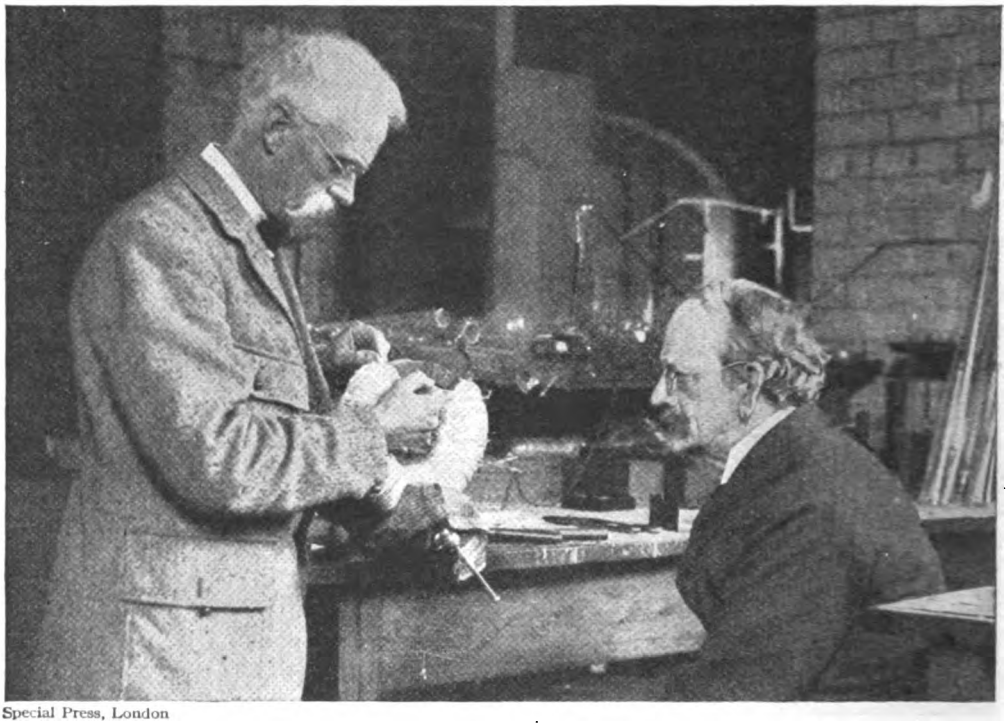
¶ *Some of the amazing possibilities that are opened up by the application of electromagnetic waves to transportation.*



Special Press, London

ONE PRESENT USE FOR ELECTROMAGNETIC WAVES

The conquest of friction by electromagnetic forces has already been accomplished inside the vacuum tubes used by Sir Joseph J. Thomson to investigate the movements of atomic particles. Professor R. Everett is explaining to Sir Joseph one of the electromagnets used in this work.

Rapid Transit by Radio

Passengers may be carried from Chicago to New York in five minutes. Freight may be hauled across the continent for a few cents a ton. These are some of the things that speculative science hopes for from the application of electromagnetic waves to transportation.

By THOMAS ELWAY

WOULD you like to leave your sea-side cottage in Atlantic City each morning at a quarter before nine and fifteen minutes later be at your desk in New York, ready for work?

Or if your home and business is in the middle west, would you like to step into the Radio Express two or three evenings a week and be whisked in a few minutes to the door of a Broadway theatre, whence you could return after the show in time for a good sleep in your own bed?

Of course, you would. A gentleman who loved the open no less than he did the Great White Way remarked once

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that the ideal existence would be to live in Texas in the daytime and in New York at night.

Well, why not?

If we want these things let us get them. They can be done. There is better than an even chance that before you and I are dead they will be done. And radio may help to do them.

The only thing that stands in the way of doing them tomorrow is friction.

To haul a railway train from Chicago to New York requires a great deal of power. Tons of coal must be burned, tons of water must be evaporated into steam, scores of men must handle and rehandle this coal and water; all in order that the necessary hundreds of horsepower be available each second to keep the train in motion.

All this power is dissipated in friction; friction of the wheels on the rails, friction of the axles as they turn in their oiled boxes, friction of the air as the train forces its way through it. If there were such a thing as a frictionless railway train you could put it on a level track at Chicago, give it one good shove and send it all the way to New Orleans. If there were no such thing as air friction New Yorkers would not need to mail their letters to Jersey City; they could stand on the dock and throw them over.

Friction is our Old Man of the Sea. Gripped on the back of our civilization he takes his toll of money and of time from every article we buy and every act we do. The copy books are wrong. It is friction—not procrastination—that is the thief of time.

Consider the city worker who commutes. Two hours a day, twelve hours a week, he pays to Old Man Friction. Even if he lives inside the city he spends an hour or so a day moving about in street cars; an hour that could be shortened to five minutes if our Old Man could be shaken off.

In the United States the daily waste of time in merely moving people around totals much more than 20,000,000 working hours; a tribute of ten or twenty million dollars daily to Old Man Friction from this one source alone.

In other ways the cost of friction is still more appalling. Take only one example; the cost of transporting food. Apples that bring fifty cents a barrel in Maine sell for five cents each in New York. An orange for which the California grower gets a fraction of a cent sells for a dime on the eastern seaboard.

Some of this difference goes to middlemen but Old Man Friction gets most of it. If there were no friction the growers could take their oranges up to the crest of the Rockies and *roll* them to New York.

The troubles of the American farmer, troubles so serious that President Coolidge has given them his personal attention, are due in the main to the high cost of transporting farm products. Old Man Friction causes them. Our coal, the engineers say, threatens to run out. Old Man Friction eats it up. The cost of transportation is the chief obstacle to

1,000 Miles an Hour on the Radio Express!

INDEED, *a speed ranging from* 10,000 *to* 20,000 *miles an hour would be entirely within the realms of possibility for a passenger-carrying car propelled in an air-tight tube by electromagnetic forces. This "electromagnetic express" could travel from San Francisco to Boston in* 20 *minutes!*

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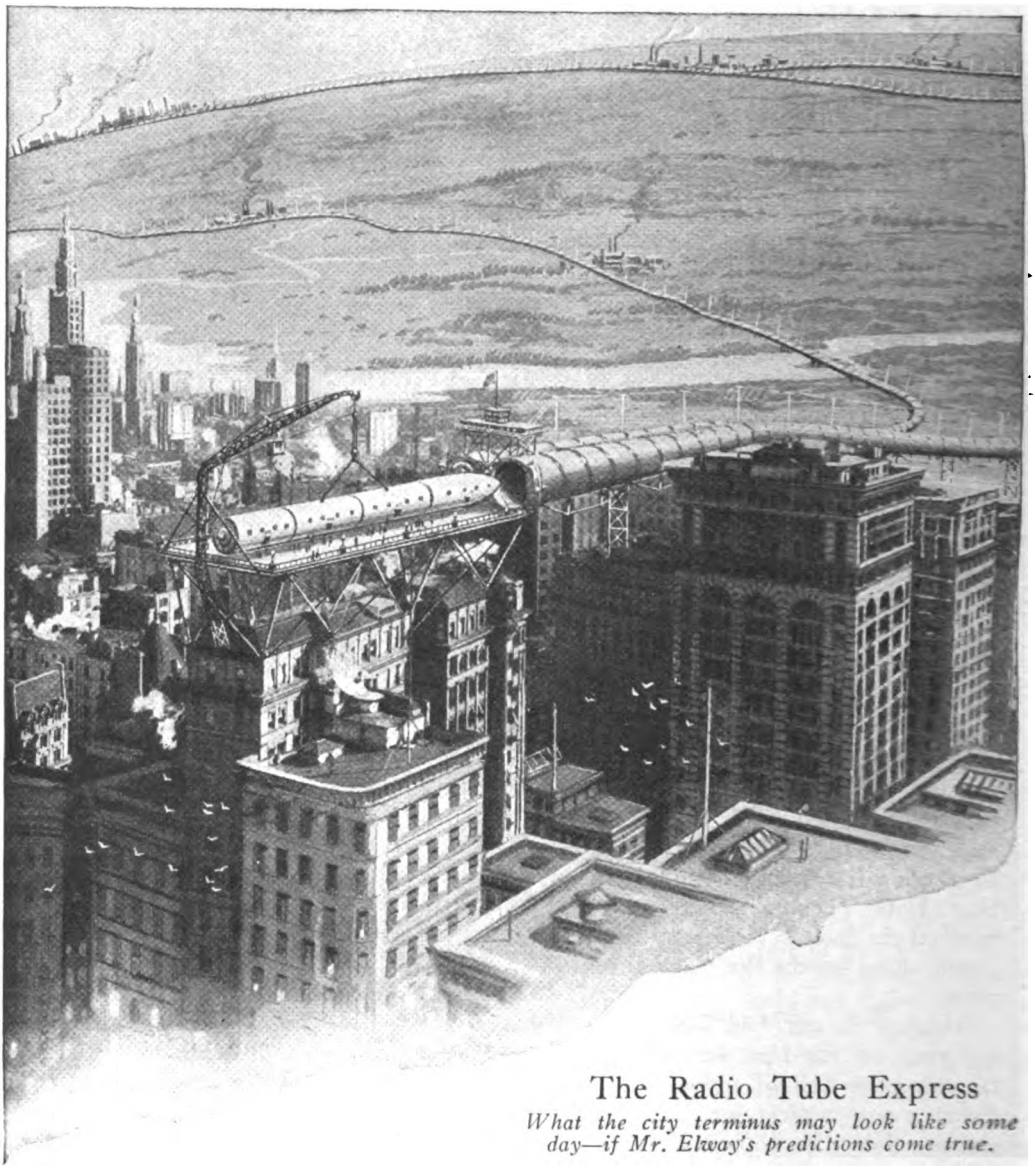

The Radio Tube Express

What the city terminus may look like some day—if Mr. Elway's predictions come true.

From a drawing made by Arthur Merrick for POPULAR RADIO

a lower cost of living and more happiness for everybody. Old Man Friction stands in the way.

"Granted," you say. "But what are we to do about it? Friction is a fact of nature, as inescapable as cold or gravity or the need of breathing air."

Not a bit of it. Friction is *not* inescapable. There are many ways in which science may be able to get rid of most of it; for example, we might invent a frictionless metal for rails and bearings.

But one of the most promising ways, so far as transportation is concerned, is likely to be the Radio Tube Express.

It would be more exact, perhaps, to call this the Electromagnetic Express, for the electromagnetic waves upon which the idea depends are somewhat different from the waves used in broadcasting though they belong to the same family. These waves can be used to

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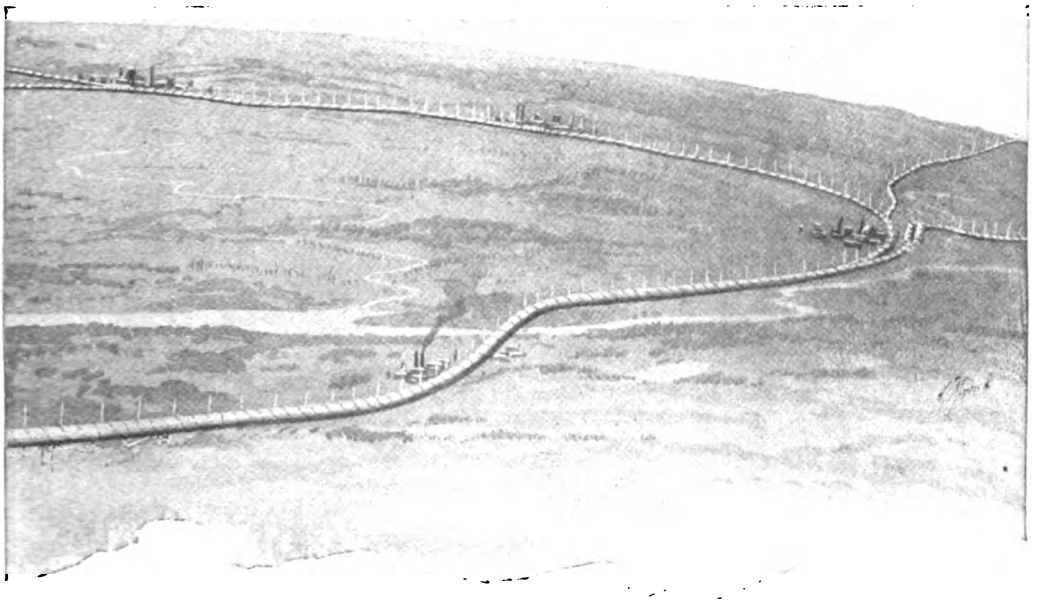

shoot freight and passengers through frictionless tubes.

You can make a small model of the system for yourself. Take some insulated copper wire and wind it onto a porcelain tube like a lead-in insulator, or onto a wooden spool with a hole in it. The hole should be about a quarter of an inch in diameter. The size of the wire does not matter much. Wind on enough turns of it so that there are eight or ten layers of the wire.

Now get a round rod of iron, like a large nail, of a size that will fit loosely inside the hole in the coil of wire. Insert one end of this iron rod into the coil, so that it goes about half way through the coil. Then pass a heavy direct current of electricity through the wire. The iron rod will suddenly jump all the way inside the coil, being pulled in by the electromagnetic waves which the current produces. This device is a familiar one in electrical engineering, being used, for example, in the electromagnetic circuit breaker, in the regulator for arc lamps and in many other items of electrical equipment.

But suppose that this small coil of copper wire were really a great tube reaching from New York to Chicago. And suppose that the electric circuits in the wire wrapped around it were so arranged that they produced a moving electromagnetic field; a field that travelled along the tube continually in the direction of Chicago. If, then, you dropped a piece of iron into the open end of the tube at New York that iron would be pulled along the tube all the way to Chicago, just as the small piece of iron was pulled inside your model coil.

Replace the piece of iron in the New York-Chicago tube by an iron car filled with passengers or freight, and you see what the radio tube express would be like.

There would be no wheel friction or rail friction to bother this express, for the car would be suspended in space by the electromagnetic forces. It would not touch the tube at all. Air friction could be eliminated by making the tube air-tight and pumping all the air out of it, so that the air-tight and air-filled car flew along in a vacuum. Air locks at the two ends would permit passengers to enter and leave and safety devices would be provided to prevent suffocation

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in case of any untoward accident.

The speed of such a device would be virtually unlimited. A thousand miles an hour would be easy. Ten thousand or even twenty thousand miles an hour is probably quite possible. San Francisco to Boston in twenty minutes; New York to Washington in the time a street car needs to go one block; such are the promises of transportation through electromagnetic tubes!

Of course, these tubes would not be cheap to build, nor would they be costless to operate. There is no promise of getting transportation for nothing. But they would eliminate the *main* cost of transportation, the cost of friction. They would take the Old Man off the back of the world.

The scientific and engineering difficulties are less serious than the one of first cost. Small tubes on this principle have been built already. One was proposed some years ago for transporting mail in cities. An electromagnetic gun, working in the same way, was invented during the war and a model of it was built.

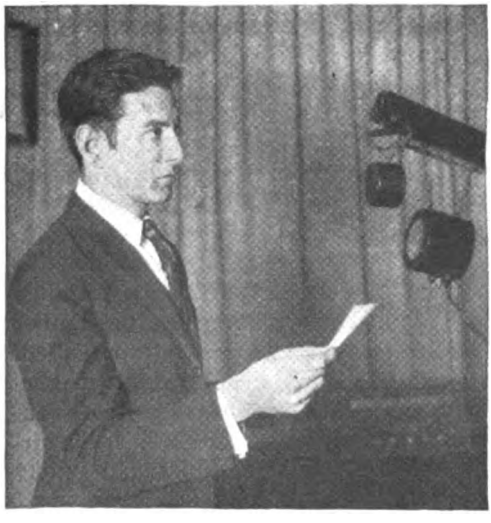
These are small beginnings but they are enough to point the way. Remember the history of the electric railway. The first one was shown as a curiosity in Berlin in 1879, less than fifty years ago. A few years before that an obscure professor in Germany had built himself a little model car that ran by electric batteries.

Everybody, the professor included, thought of this little car as a toy. To haul a man in one would have cost something like eighty dollars a mile. It was cheaper to hire a horse or a hundred horses than to use such a car. To build an electric railway on this basis would have cost many billions of dollars.

Nevertheless, electric railways were built and they did not cost billions of dollars. They proved to be cheaper and more practicable than anybody foresaw. Perhaps the express service in electromagnetic tubes will come to practicability in the same way.

There is one thing, I am convinced, which we may confidently expect. If our great-grandchildren do not ride to work at a thousand miles an hour in electromagnetic expresses and shoot their oranges east from California in radio tubes, it will be because these same things have been done in some better way.

Old Man Friction is a load that Civilization must shake off. And Civilization will do so.



The First Announcer to Introduce American Programs to South America

Station KDKA at Pittsburgh has been heard so consistently in South America that the directors of that station have decided to put on regular programs in Spanish for the benefit of listeners in our sister continent. Señor D. Santini, who served as announcer when the first of these programs was broadcast recently, was born and educated in the Argentine Republic, though he is now a radio engineer in the United States.

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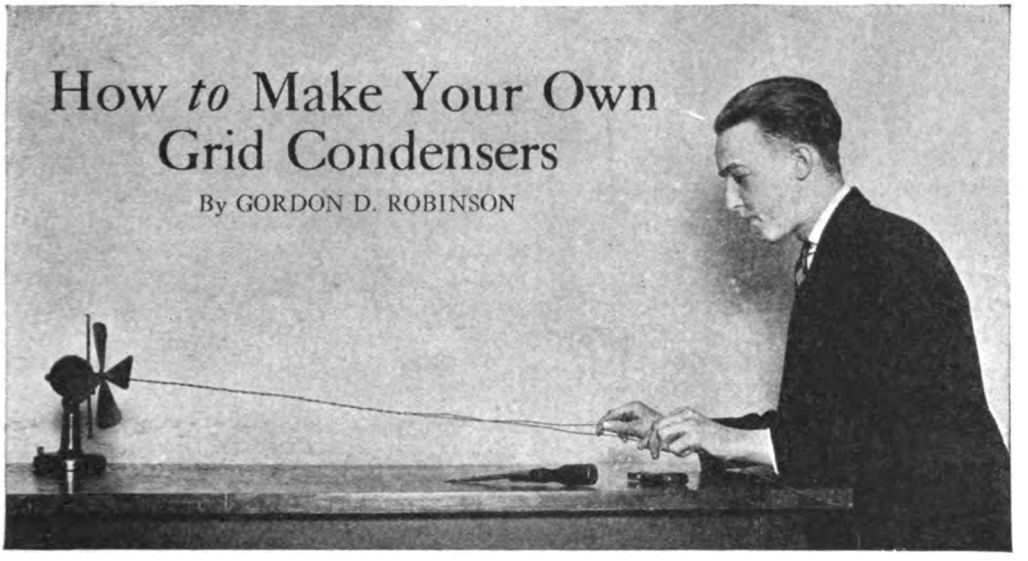
How *to* Make Your Own Grid Condensers

By GORDON D. ROBINSON



Do you know that a unique condenser may be made with the help of your electric fan? Merely twist together two lengths of insulated wire; the copper conductor will form the plates and the insulation will take the place of the dielectric.

HAVE you a few feet of magnet wire and a small lump of paraffin? If you have, you can make yourself all the grid condensers you need with no expense and little work. You do not even have to be particular about the size of wire; almost anything from No. 24 to No. 36 will do. If you have it, use double cotton-covered magnet wire; thinner insulation will give somewhat more capacity, but won't stand as much voltage.

Suppose that you want to make a grid condenser for a detector tube. This is how to do it:

Take about twenty feet of magnet wire (any size that you have handy), and double it. Get out the sewing machine, the electric fan, the old spark-gap motor or anything else you have handy that revolves rapidly. Fasten the two ends of the piece of wire to the revolving shaft and hold the rest of the wire out straight so that it can be twisted. Now start the motor, or whatever you are using, and run it until you have a twisted pair with several twists to the inch. If you follow these instructions properly you will now have about ten feet of twisted pair. In order to get two separate conductors and to get rid of any broken insulation at the ends, cut off six inches or so from each end of the pair. With several thicknesses of paper or tape carefully insulate each wire at one end of the pair, beginning with the insulated ends and wind the two wires on a match stick, leaving just enough wire unwound to connect the condenser where wanted. Now dip the wire into hot paraffine and keep the paraffine hot until the insulation stops bubbling. Let the paraffine cool until it is about to solidify before you take out your condenser. When the wax has finally set you have the finished condenser.

Can these condensers be made to be used with power tubes? They certainly can. Several months ago the author made two such condensers from about No. 26 double cotton-covered magnet wire; since that time these two condensers have been used in the grid circuits of two quarter K. W. tubes with

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entire satisfaction. The exact voltage applied to these condensers is not known, but it was found that when working at full power as much as two amperes was indicated by a hot-wire ammeter in the common grid circuit of these two tubes.

The capacity of a condenser of this type is determined principally by the length of wire used. For a given length of wire, and kind of insulation, various sizes of wire will give nearly the same capacity. If the condenser is used with a power tube, use only double cotton-covered magnet wire not finer than No. 28.

The Radio-Grouch

THIS is a wonderful age. By simply turning a few knobs I can let a lot of total strangers into my house. A man's home is no longer merely his castle; it is a Chautauqua.

* * *

A RESIDENT of rural Connecticut can now enjoy all the discomforts of New York life without suffering any pain in his New England thrift.

* * *

IT is a wonderful thing to sit in a Minnesota farmhouse and personally hear a European statesman explain why they can't pay us what they owe us.

* * *

A WASHINGTON man is now sending pictures by radio. The one I saw made me very happy. I was glad I didn't know the man personally. I hope they don't carry this too far. A great advantage of the radio concert is that you can hear the singing without seeing the singer's mouth.

* * *

ANOTHER good thing is the sleeping accommodations. The Metropolitan Opera House has never done the right thing by our sleeping classes. The seats are narrow and uncomfortable. For all the sleep you get you might almost as well be in a Pullman. With the radio all this is changed. You can get yourself comfortably stretched out, turn on a good German opera and have a refreshing evening. The radio is the finest cure for insomnia that has come into the world since Gibbon wrote "The Decline and Fall of the Roman Empire."

* * *

No wonder statesmen love to broadcast. It's a wonderful thing to be able to talk to people who can't talk back.

HOWARD BRUBAKER

* * *

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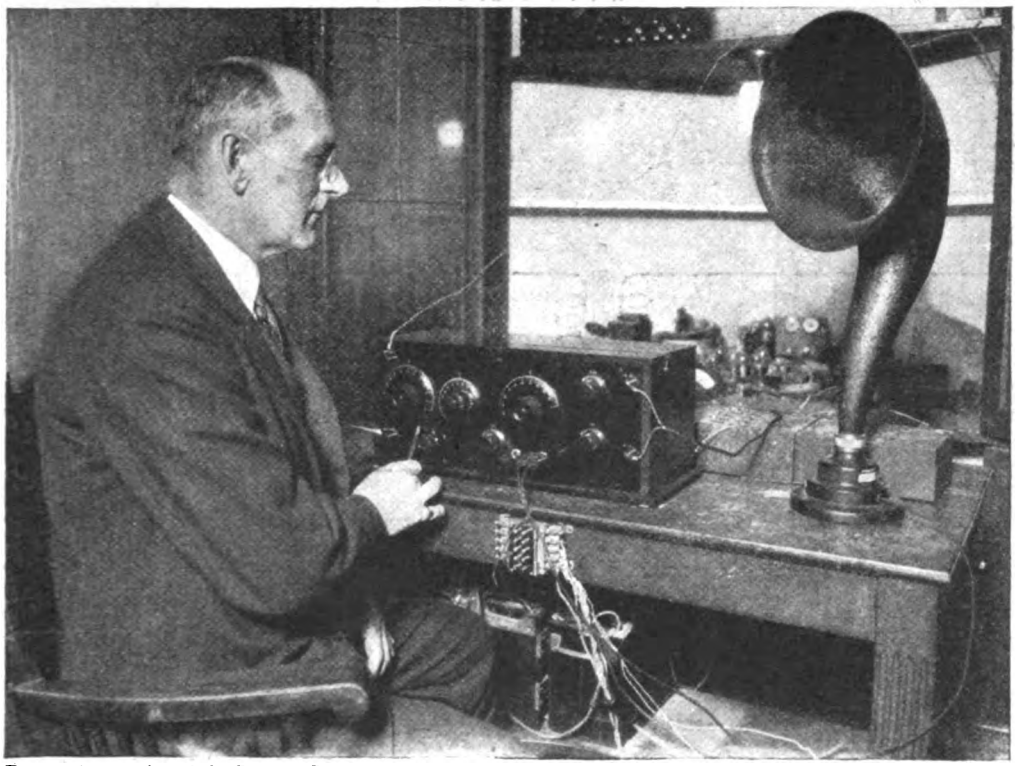

From a photograph made for POPULAR RADIO

THE AUTHOR TESTS THE RECEIVER

In testing the set in the laboratory, a short length of wire was strung up around the picture moulding for use as the antenna and another piece of wire was attached to the radiator. The volume of signals was remarkable.

HOW TO BUILD A

REGENERATIVE RECEIVER

—For Use With an Indoor Antenna

This article has been prepared for the special benefit of the radio fan who is so situated that he cannot install or use to advantage the standard type of outdoor aerial.

By ADRIAN M. TOBIAS

COST OF PARTS: *About $55.00*
RECEIVING RANGE: *Up to 1,500 Miles*

HERE ARE THE ITEMS YOU WILL NEED

A—Inductor (dimensions and winding data are given in the text of article);
B—Bradley leak, variable ½ to 10 megohms;
C—Thordarson condenser, 13-plate variable with vernier, approximate capacity, .00025 mfd.;
D1, D2 and D3—Amsco improved 20-ohm rheostats;
E—Coto-coil No. 8,000 variometer;
F1—Thordarson super transformer, 3½ to 1 ratio;
F2—same, 6 to 1 ratio;

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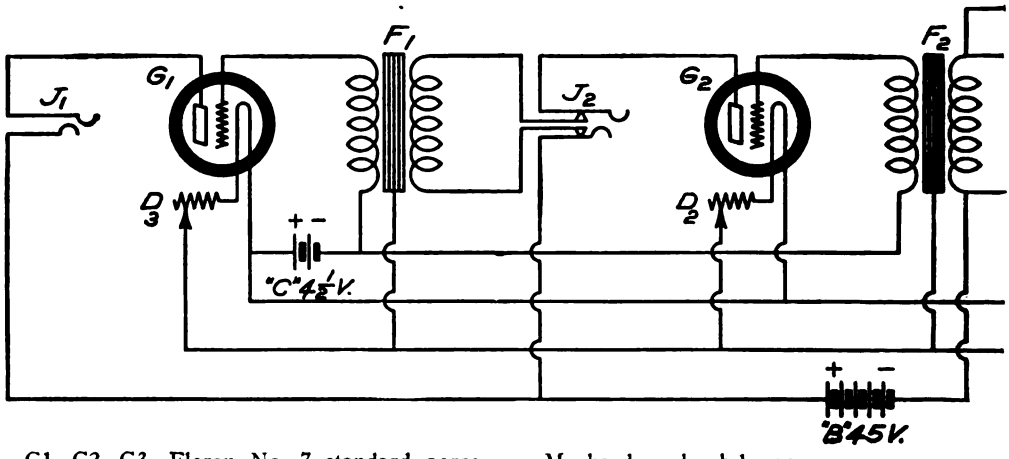

G1, G2, G3—Fleron No. 7 standard porcelain sockets;
H—Amplex grid-denser—small variable condenser;
J1—Saturn phone jack, single-circuit;
J2—Saturn phone jack, double-circuit;
K—composition "B" battery binding-post block;
L—New York Coil Co., mica-fixed-condenser, .00025 mfd.;
M—hardwood sub-base;
N—composition panel;
O—Eby binding posts;
P and P1—Radion hard rubber dials; 4-inch diameter;
stock cabinet, 7 inches by 18 inches, as shown in Figure 7. Necessary connecting wire, varnished-cambric tubing, wood screws, etc., etc.

TO find a suitable location for a good outside antenna with the necessary lead-in, and outside ground connection through approved lightning arrester, has become a serious problem. Congested city districts especially preclude the possibility of finding an open space sufficient in area to get the proverbial hundred-foot run, free from obstructions. To find a really good location on *any* city apartment building could be likened to the historic search of Diogenes.

In view of these conditions, some form of interior antenna or collector seems to be the logical answer. However, the usual three-tube receiver, when operated with wire strung around a room, loses so much of its sensitivity that loudspeaker reception on fairly distant stations is usually out of the question.

The writer was confronted with the conditions here outlined and has experimented with a circuit employing three tubes that gives loudspeaker reception on stations up to 1,000 miles or so. A length of about fifty feet of bell wire strung around the picture moulding of two rooms is sufficient for the antenna.

POPULAR RADIO has repeatedly set forth the several qualities that a radio set must have in order to be considered in the popular class. These qualities may be enumerated as follows:

1: It must be selective;
2: It must be sensitive;
3: It must be easy to construct;
4: It must be inexpensive;
5: It must be easy to operate.

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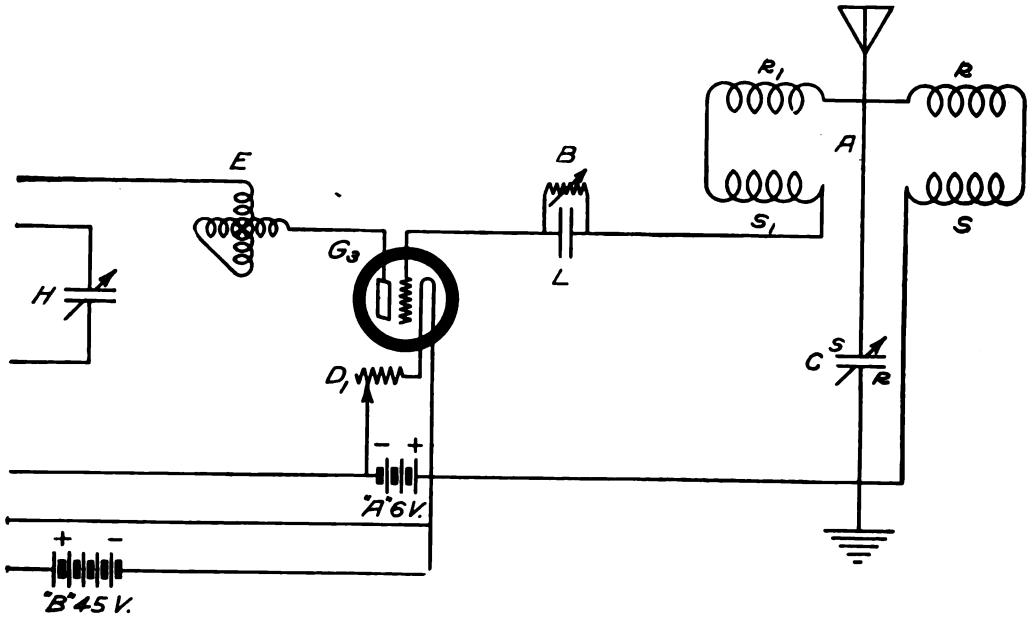
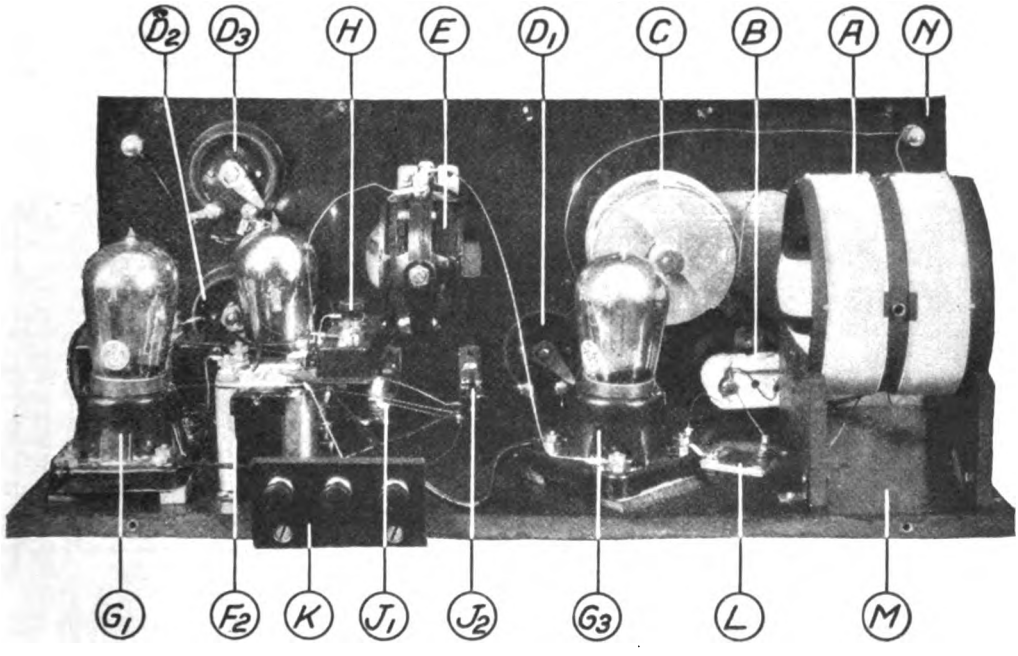


THE ELECTRICAL WIRING DIAGRAM FOR THE RECEIVER

FIGURE 1: *This includes all the connections for the various instruments and parts that go to make up the completed set. All the parts are marked with designating letters which are repeated in the text and the list of parts. The diagram reads from* RIGHT TO LEFT *to facilitate wiring.*



THE REAR VIEW OF THE SET

FIGURE 2: *This picture shows the general arrangement of all the instruments fastened to the panel or to the base. The exact locations for the instruments are given in Figure 3.*

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The circuit described in this article will easily choose between, or separate, stations with a difference in operating wavelength of only five meters. In New York City, for example, when station WHN is operating, WDAP in Chicago can be tuned in on a loud-speaker without interference. Both stations are in the 360 meter class. (Point No. 1.)

This set is highly sensitive—as is evidenced by the fact that it gives loud-speaker reception up to 1,000 miles on an indoor antenna. (Point No. 2.)

Ease of construction is a relative term. This set is no harder to construct than any other double-circuit receiver. (Point 3.)

Low cost of construction is also relative; the cost of building the set here described, however, compares favorably with the cost of building any three-tube regenerative receiver. (Point 4.)

The operation of this set is really simple and the set will give good results. (Point No. 5.)

In the building of such a set careful attention to the constructional details is highly important.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of the transmitter may easily determine how to mount the instruments in the correct places and connect them properly in the electric circuit. The same designating letters are used in the text and in the list of parts at the beginning of the article.

¶ *The list of parts there given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

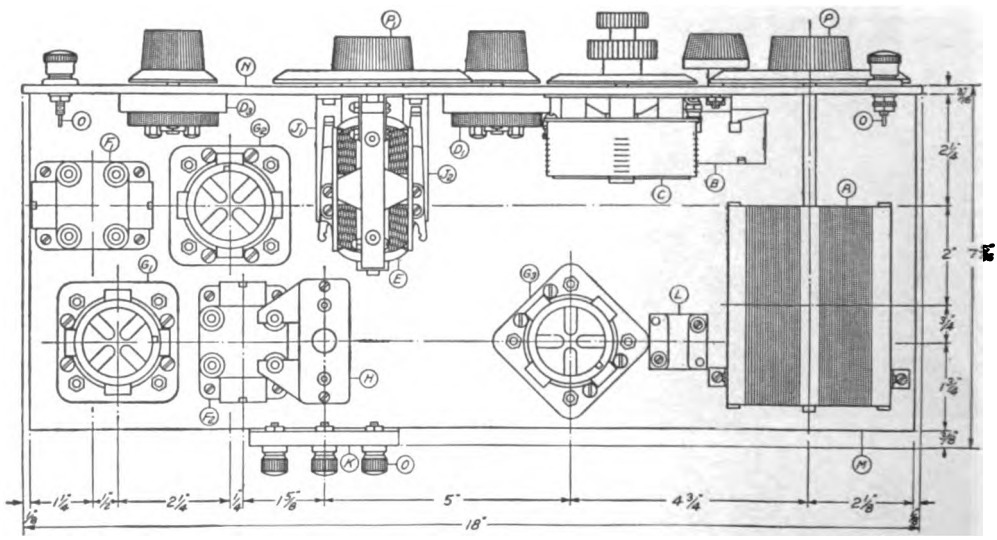
How to Construct the Set

It is presumed that the prospective builder is provided with an assortment of small tools before he attempts to build a radio set. Having the necessary tools, use the utmost care in mounting each and every part and above all, *do not hurry.* Consider every operation as vital and thus avoid disappointment.

When all the necessary parts and materials have been obtained, prepare the panel as the first operation. A stock size 7-inch by 18-inch panel, N, is usually cut to size so close to the specified measurement that no "dressing up" will be necessary.

Lay out the holes on the panel with a center punch as shown in Figure 6. For the larger holes such as those for shafts, jacks, etc., it is a good plan to use a smaller size drill first (about a No. 34), and then follow up with the proper sized drill.

The holes outlined in the diagram with a double circle should be countersunk so that the flat-head machine screws, used for fas-



THE WORKING DRAWING FOR CONSTRUCTION

FIGURE 3: *Here are shown the correct positions for the various instruments. The positions are given center to center, for all instruments.*

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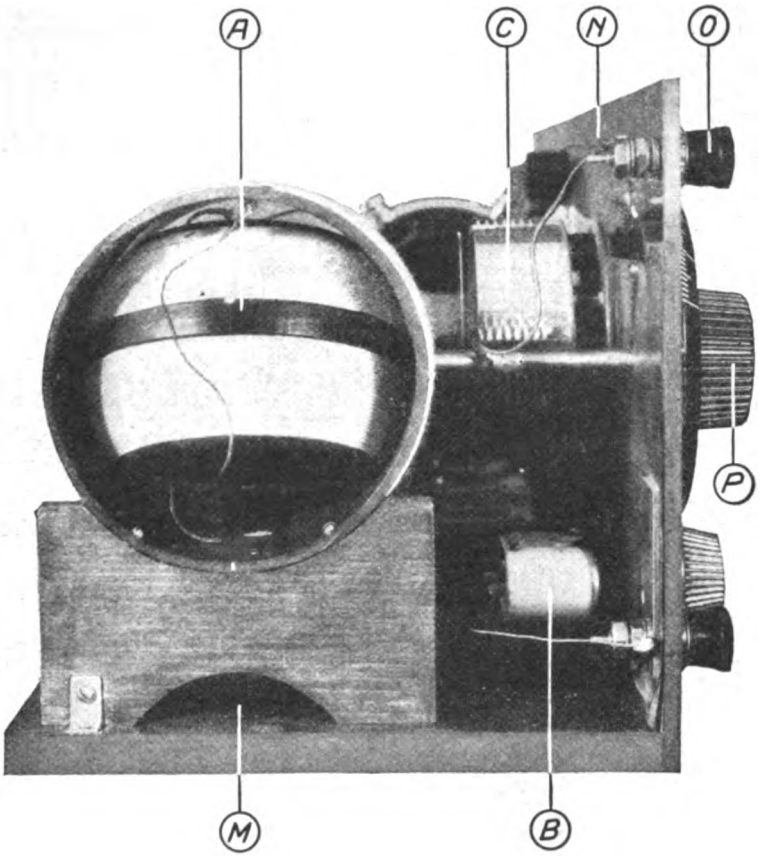

THE SET AS SEEN FROM THE LEFT

FIGURE 4: *This diagram shows the way to mount the inductor, the variable condenser and the grid-leak and binding posts for the antenna and ground connections.*

tening the various instruments, will be flush with the panel. The panel diagram does not give the size of holes to be drilled because the builder will be best guided by the size of machine screws that usually accompany the parts. However, it is good practice to drill a 5-16 inch hole for all ¼ inch shafts (excepting for the inductor shaft), thus assuring ample clearance. Use care in drilling and handling the panel to avoid scratches on the polished surface.

The sub-panel or base M should be cut from thoroughly dry, yellow poplar or white wood ½ inch by 6¾ inches by 17¾ inches. (See Figures 2, 3, 4 and 5.)

Next, mount the grid-leak B on the panel by means of two screws.

Then mount the two jacks, J1 and J2, the three rheostats, D1, D2 and D3, and also the four binding posts, O, as shown in Figure 3. The variable condenser C, the plate variometer E, and the inductor A are not mounted until after the panel is attached to the base by means of 5 wood screws.

Attention should now be given to the mounting of the parts on the wooden base. Begin with the connection block K (see Figures 3 and 9) for supporting the three "B" battery binding posts. Use soldering lugs under the nuts on these binding posts and bend them down at right angles to make it easier to solder the leads to them, when wiring. After attaching this block to the base, mark the location of all screw holes for mounting the transformers F1 and F2, and the three tube sockets, G1, G2 and G3. Use an awl so as to provide an easy means of putting in the wood screws that hold these parts to the base. Before attaching the transformers, F1 and F2, scrape the finish from around the screw-holes or the bases (looking down from the binding post marked "plate" on each transformer). This will make a good contact spot, for the small soldering lug (placed under the mounting screw) which will provide for grounding the cores of both of the transformers.

The next job will be to construct the inductor A, see Figure 8.

To begin with, proper materials for making the inductor are essential and should include

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the following: a No. 2 (Radion) hard-rubber tube, which is 4 inches in (outside) diameter, and 3½ inches long; one No. 012B (Radion) hard-rubber rotor; one 8-inch length of brass rod, ¼ inch in diameter; a small spool of No. 20 DCC copper wire; two 7-inch lengths of about 16-strand, silk-covered, "pig tail" wire, and a dozen round, hardwood toothpicks and some ¼-inch cotton tape.

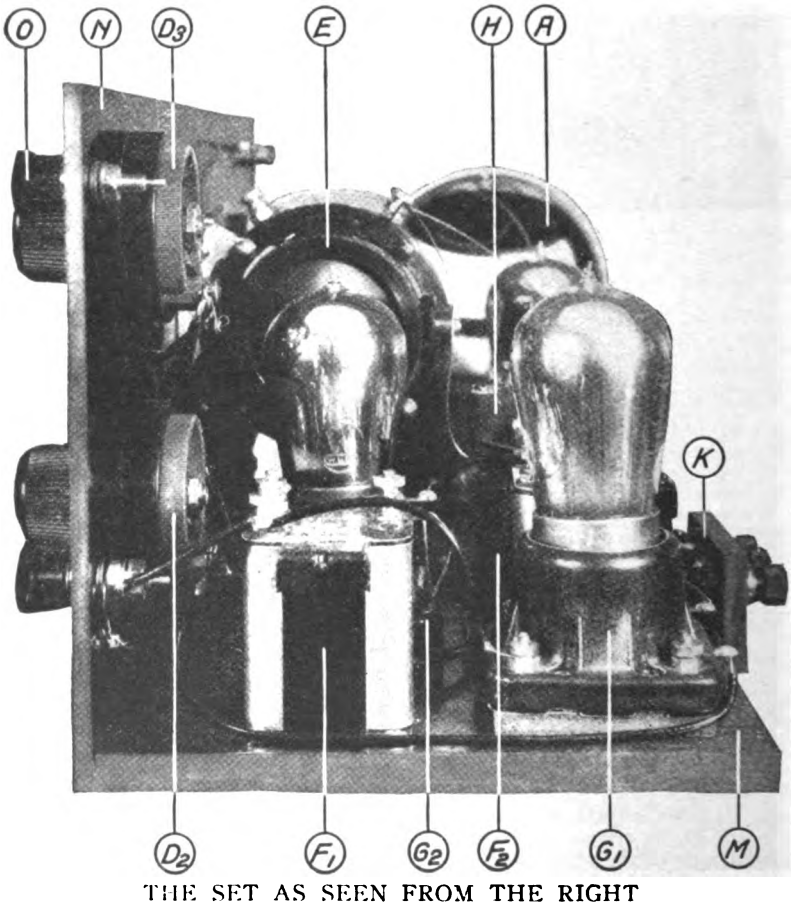
Begin by drilling the ¼-inch holes in the rubber tubing for the brass shaft that passes through the tubing and rotor. Locate these holes correctly (midway between the ends of the tube and exactly at right angles to the axis) for there is only a small clearance between the rotor and the tubing.

There should be a ⅜-inch space left between the two stator windings. Therefore, draw two pencil lines around the tubing so that they will pass within 1/16 inch of the edges of the holes for the brass shaft. These pencil lines should be concentric with the axis of the tube and will form guide lines for the first inside turns of the stator windings.

Have ready about a dozen pieces of the ¼-inch dry cotton tape cut into ½-inch lengths; also cut about a dozen of the toothpicks in half.

Next, mark one of the shaft holes so that this side will be known as the front, and viewed thus, the right-hand stator will be the grid winding and the left will be the ground winding. Now drill two small holes ¼ inch apart, on the guide line, for the start of the grid winding. These holes should be made with a No. 48 drill and should be located horizontally on the bottom of the tube.

Start winding the grid stator with a clockwise motion (looking at the tube from the right end) and place three pieces of the cotton tape so that the wire passes over them about in the middle. These three pieces of tape should be spaced equally around the periphery of the tube. When one complete turn is wound on, fold the loose end of the cotton tape back over the first turn, so that the second turn will hold it fast. (See Figure 9.) This prevents the wires loosening up. Then continue until 25⅛ turns have been put on and finish the winding by drilling a small hole with the same-sized drill, pull the wire through



THE SET AS SEEN FROM THE RIGHT

FIGURE 5: *This view shows the position for the transformers, the tube sockets, the variometer, the filament rheostats and the two binding posts for the "A" battery.*

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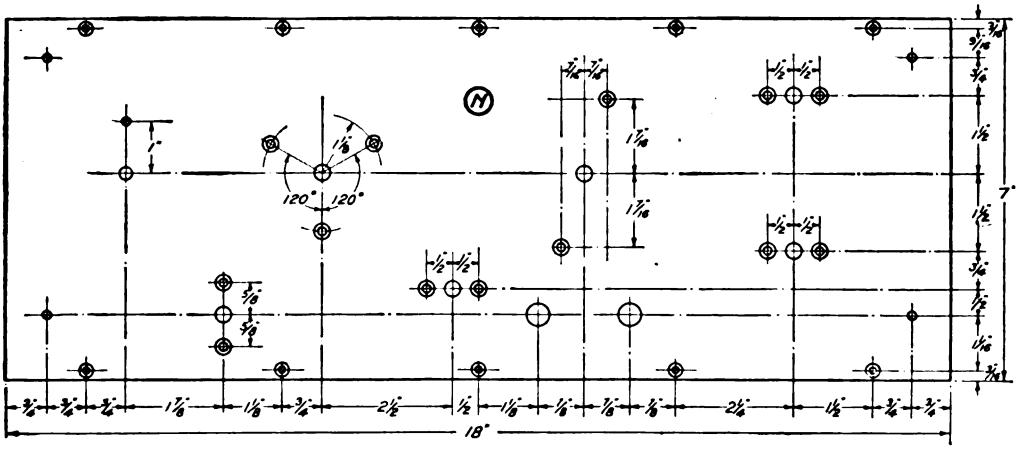

THE DRILLING PLAN FOR THE PANEL

FIGURE 6: *This drawing shows where to drill the holes for the screws and shafts of the instruments which protrude through the panel. The holes outlined with a double circle should be countersunk so that the flat heads of the screws will set flush with the panel.*

and wedge in the hole with a piece of hardwood toothpick driven securely in. Leave a piece of wire, about six inches long, projecting on both ends of the winding.

Now drill two other holes near the finish of the winding, spaced around the periphery in the same manner as the cotton strips, and insert pieces of toothpicks to prevent the windings from loosening or slipping.

Now proceed in the same manner to wind the ground stator.

When these two are completed, the next job will be to prepare and wind the rotor coils. It will be found that the rotor ball has a center rib running around its circumference, that is, 5/8 inch wide. This will have to be dressed down with a penknife and sandpaper to 3/8 inch, to make room for the 25½ turns of No. 22 DCC wire.

As hard rubber works easily, this can be done with a good sharp pocketknife. Begin winding by drilling hole at outside edge and midway between shaft holes. Secure this start with hardwood pin, leaving about ¼ inch free end of wire on inside of rotor and wind in same direction as stator. Put on 25½ turns, drill through and pin this inside end of first half of rotor. About 2 inches free end is required on inside of rotor. Wind the other half of the rotor, starting on opposite edge from winding of first half, which will bring the two loose 2-inch free ends on inside of rotor at right angles to each other. These 2-inch ends are the terminals of the two halves of rotor and terminate at rib of rotor.

Clean all ends of the windings ready for soldering and then mount the rotor inside of the tube by means of the brass shaft. Take one turn around brass shaft with both of the 2-inch free ends inside of the rotor and solder securely to the shaft.

Conclude connections by soldering the two 7-inch lengths of "pig tail" to the stator and rotor terminals. One end goes to the outside terminal of the grid stator and the other end goes to the outside terminal of the rotor winding. The other 7-inch length is used to tie together the outside terminal of the ground stator winding and the outside terminal of the other half of the rotor winding. The inductor is now finished and ready for mounting in the set.

Shielding the inductor is optional, although recommended, as even slight body-capacity effect is annoying in such a selective tuner. A thin sheet of copper, cut as shown in Figures 2 and 4, is sufficient. Cut an opening about 5/8 inch in diameter where the inductor shaft projects through the panel N and mount the variable condenser C directly over the shield, as this forms a grounded connection for the rotary plates of the condenser. Use a large size washer on the ground binding post for making contact with the shield.

Next, attach the plate-circuit variometer E to the panel N and mount the tuning inductor A on the wood base. Attach a dial to the plate variometer E, and one to the condenser C and also to the inductor A. On account of the flexible connections on the shaft and the rotor of the inductor, some form of stop is necessary. Insert a 4-36 machine screw in a tapped hole located on the panel N 1 inch up from center of rotor-shaft hole. (See Figure 4.) This machine screw should be about 3/8 inch in length and should be inserted from the back of panel. It serves to hold the sheet copper shield securely to the panel (use thin brass washer under head) and provides a good stop for the inductor by engaging with the slot found in the back of 4-inch hard-rubber dial. Use care in mounting the inductor, so that the shaft may move freely, covering the entire scale shown on the dial. When the instruments have been mounted the set is ready for wiring.

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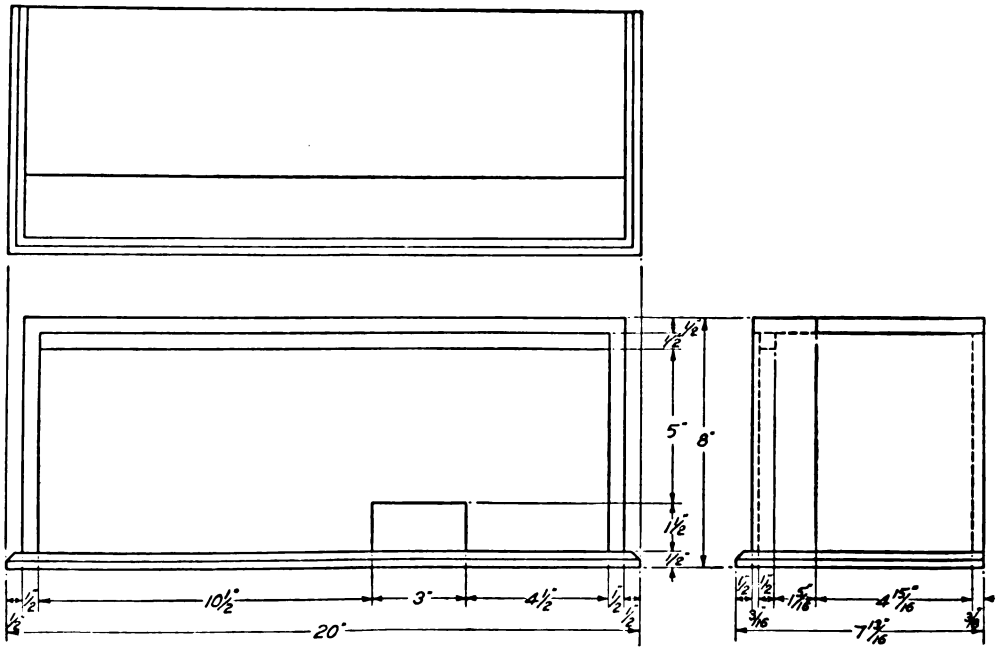
How to Wire the Set

It is recommended that No. 18 SCC be used for all wiring. Cover the "A" battery leads (only) with varnished-cambric tubing. For all other wiring remove the cotton covering and use the bare wire.

Begin winding at the positive "A" binding post. If soldering lugs are used, put one under each screw (nearest the "off" position) on each amplifier rheostat. The two lugs for grounding the transformer cores should be placed under the screws for fastening the transformers F_1 and F_2 to the base and should have the tips bent up or offset so that when the wires are soldered to them they will be about ¼ inch above the base. Allow a sufficient length of wire to reach from the positive "A" binding post without a break to these lugs. Slip on a piece of tubing long enough to reach to the soldering lug on the upper or second-stage rheostat D_2. Solder to this lug. Continue in this manner to first-stage rheostat D_2, and then to the lugs at the base of each transformer and then on to the negative "B" binding-post lug. From this point run direct to the positive F binding post on the detector-tube socket G_3. Continue the positive "A" battery circuit by attaching leads from each amplifier rheostat and run direct to the positive F binding post of the two amplifier tube sockets G_1 and G_2. The negative battery connections are made by running from the negative F on the detector socket G_3 to the rheostat D_1 and thence along the panel under the jacks J_1 and J_2 to the negative "A" binding post. Next, begin with the negative F binding post of the second-stage tube socket G_1 running a wire to the negative F terminal on first-stage socket G_2 and on to the negative "A" binding post. Connect the two negative filament binding posts on the transformers with a lead around to the negative "C" battery and from the positive "C" battery run a wire over to the negative "A" binding post. This concludes the "A" battery or filament connections.

All plate battery leads are made with bared wire. The transformers and tube sockets are so placed that short leads can be made from the grid posts on the tube sockets to the respective posts on the transformers. After these two connections have been made, attach a lead to the plate binding post of the second-stage tube socket G_1 and solder it to the bottom tip or blade of the single-circuit jack J_1. Then solder one end of another wire to the top tip of the same jack and thence to positive "B" amplifier binding post. Attach a lead to second tip from bottom on the double-circuit jack and go from here direct to the B+ post on the second-stage transformer F_1. A lead is then soldered to third tip from bottom on double-circuit jack J_2 and taken direct to the binding post marked P on the second-stage transformer F_1. Then bring a lead from the top tip of the same jack, direct to the plate terminal of the first-stage tube socket G_2.

Finish the wiring job by soldering a short



THE DIMENSIONS FOR THE CABINET

FIGURE 7: *This drawing (which contains the top, front, and side measurements for the hardwood cabinet) may be turned over to a competent cabinet worker who can build it from these instructions alone.*

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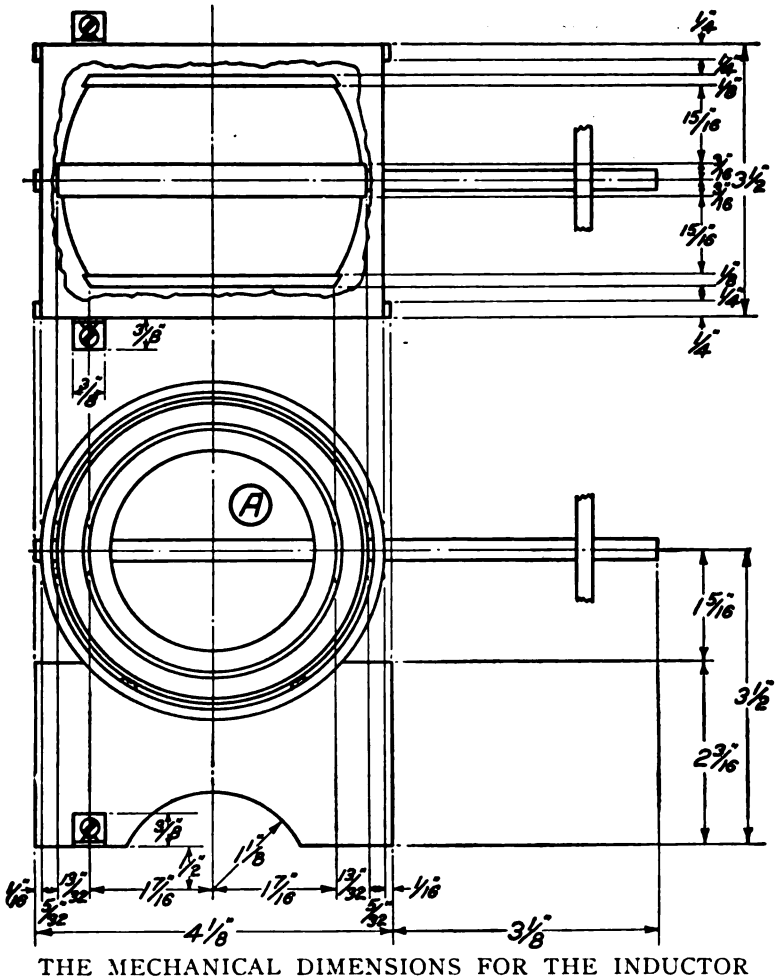

THE MECHANICAL DIMENSIONS FOR THE INDUCTOR

FIGURE 8: *The top diagram shows the inductor as seen from above; the lower diagram shows the inductor as seen from one side and contains the measurements for all the parts including the rotor, the stator, the wooden base and the brass shaft.*

lead to positive "B" detector binding post and carry this lead to the B+ binding post of first-stage transformer F_2. Mount the grid-denser H and carry a lead from the binding post marked P on the transformer F_2 to the plate variometer E and from the other terminal of the variometer run a wire to the plate post on the detector-tube socket G_3. Connect the variable condenser C in the circuit with a lead running from stationary-plate binding post to the antenna binding post on the panel N. Next, attach a short length of "pig tail" wire to the antenna binding post and solder the other end to the inductor shaft. The lead from the inside winding of the left-hand stator is now soldered to the ground binding post. The inside terminal of the right-hand stator is now attached to the grid condenser L. Now attach a short wire (not over ¾ inch long) to the grid post of the detector-tube socket G_3 and solder the other end of this to the lug on condenser L. Finally, solder leads from the grid-leak to the lugs on the grid condenser and the wiring is complete. Check over the connections carefully to be sure they coincide exactly with the wiring diagram in Figure 1.

How to Operate the Set

After every detail of wiring and assembly of parts is completed, the set is put into its cabinet. It is fastened securely by two 1¼ inch No. 7 flat-head, brass wood-screws inserted through the back of the cabinet into the wood base, and five ¾ inch No. 4 flat-head, brass wood-screws inserted, at top of panel, into the cabinet.

The binding posts on the connection block K will now protrude through the slot cut for them in the back of the cabinet.

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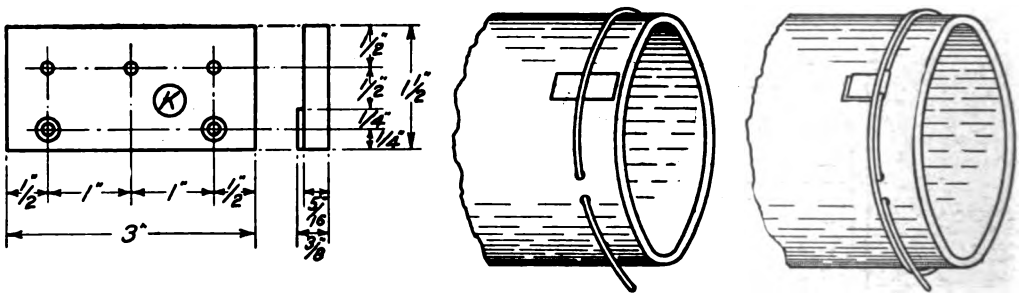

THE CONNECTION BLOCK AND THE METHOD OF SECURING THE WINDINGS

FIGURE 9: *This diagram contains, at the left, the dimensions for the small binding-post panel for the "B" battery connections, and at the right the way to start the winding on the inductor—by folding a small piece of cotton tape to keep the first wire from slipping out of place.*

Put the set in operation in the following way:

Provide a permanent inside antenna of ordinary annunciator wire or stranded, silk-covered wire of a color to match interior decorations. Preferably about 30 to 50 feet of either can be concealed back of the picture moulding. String the wire continuously *away* from the set by dropping down from the moulding through a doorway into another room, rather than running a large loop around the four sides of one room.

Of course, if you are anxious to get the set going quickly, just throw 15 feet or more of bell wire on the floor, or out of the window, with one end attached to antenna binding post.

The ground connection is made to a steam radiator or a cold-water pipe and to lower left-hand binding post of the set.

The upper right-hand panel binding post should be connected to positive "A" battery (6 volts).

The lower right-hand panel binding post is then connected to negative "A" battery.

Attach the negative "B" battery lead to the first post at the right, on connecting Block K at rear of set.

To the middle post attach detector positive "B" battery (45 volts).

To the remaining post, attach amplifier positive "B" battery (90 volts). The "B" batteries consist of two 45-volt sections connected in series with a tap in the center (45 volts) for the detector plate.

With all rheostats in the "off" position insert a UV201-a tube in the detector socket G3.

Insert two UV-201-a tubes in the remaining sockets G1 and G2.

If telephones are used, the plug should be inserted in the first jack J2 and the rheostats D1 and D2 turned up about half or three-quarters of the way. Next, turn the grid-leak knob B (clockwise) until slight compression is noted.

Then set the grid-denser H by turning knob (clockwise) until fairly strong compression is felt in turning.

See that the main dial of the variable condenser C is set somewhere near 18 or 20.

The plate variometer dial P1 should be set at about zero.

Rotate the inductor dial P very slowly until you hit your first station—bringing up the regeneration by rotating dial P1.

As condenser C is also an element of the tuning, rotate the vernier for clearing up the signal.

Then go back to dial P, this time holding the rubber end of an ordinary lead pencil against the panel at an angle and engaging the edge of the 4-inch dial. A slight twist in either direction gives a splendid vernier effect.

The detector rheostat should be set just below the oscillation point and the control of oscillation is obtained by an adjustment of the grid-denser H.

Keep the filament turned fairly high, thus requiring a lower value of plate inductance for stable operation. A certain combination of these two adjustments will bring in the signals clearer, and with the least distortion.

It will be found that there is a "best combination" of inductance and capacity for the different wavelengths. When these points are found—make a record of them, for it is then a simple matter to tune in the various stations.

Practical Pointers for Experimenters

BEGINNING *with the next issue,* POPULAR RADIO *will publish, each month, a new department that will contain helpful hints for readers who build the sets described in this magazine.*

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¶ "Why risk life, money and time on North Pole explorations?" asks the layman of the scientist. Here is one answer.

From a drawing by Arthur Merrick for POPULAR RADIO

WILL WE RUN THE WORLD'S MACHINERY WITH

Radio Power from the Pole?

Everybody knows that the frozen north contains great stores of coal. But nobody knows how to get it out and bring it down to civilization. The author of this article—himself both an arctic explorer and a radio expert—here proposes the most plausible method that has yet been suggested for using this now useless store of power.

By LIEUTENANT COMMANDER FITZHUGH GREEN, U. S. N.

ONE black arctic night in February, 1915, at Etah, North Greenland, I sat toiling over an old-fashioned Telefunken spark gap with nothing between me and a howling blizzard except the thin walls of our ten by fifteen radio shack. New York was nearly 3,000 miles south; and the sun had been gone since October 19th. Allen, our radio expert and my only companion, had taken leave of me some hours before. He was bound for the main headquarters near the glacier. I was alone.

Suddenly above the pounding of the wind and the hiss of drifting snow I heard a strange sort of scratching sound.

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My hair seemed to rise. At once I knew what to expect. One of the huge polar bears that were always prowling about had discovered our tiny refuge. And since bears are very hungry at this season of the year, especially when violent wind disturbs their winter slumbers, I at once prepared for a fight.

I made sure that my Winchester .35 had a full magazine and that one round was in the barrel. I cocked it carefully and extinguished the light.

The scratching became more insistent. Polar bears are clever. I think one could pick a lock if he had a little practice.

The outer door creaked. Then its latch snapped. A furry mass plunged in and landed with a thud at my very feet.

It was not a bear at all, but the radioman, Allen. Gasping for breath and badly frost-bitten he told me that he had been unable to reach the base and had been nearly blown into the Sound in his frantic efforts to reach the shack again.

"This part of the world is certainly no place for radio!" he concluded with an emphatic shake of his head.

By now he is willing, no doubt, to eat his words. For it begins to look as if the North Pole were going to be a very important factor in the development of radio physics and related phenomena.

Five arctic expeditions are scheduled to leave by the first of next July. Our dirigible *Shenandoah* flight would have made a sixth. Also France was planning to send her dirigible *Dixmude* north at the time it was struck by lightning in the Mediterranean. MacMillan, as all radio fans know, is now at Etah, Greenland; Rassmussen is in Coronation Gulf, above Canada. And Amundsen's ship, the *Maud*, is drifting north of Siberia frozen fast in the Polar ice pack.

The principal aim of all these expeditions is to explore the 1,000,000 square

From a photograph made for POPULAR RADIO

"RADIO-EQUIPPED EXPEDITIONS NORTHWARD ARE MATTERS OF IMPORTANCE TO RADIO SCIENCE"

Indeed, the problem that civilization faces in our rapidly diminishing coal supply may conceivably be met by explorers and radio engineers when the underground fuel supplies near the poles are finally tapped, believes Lieutenant Commander Green, of the Naval War College at Newport, R. I.

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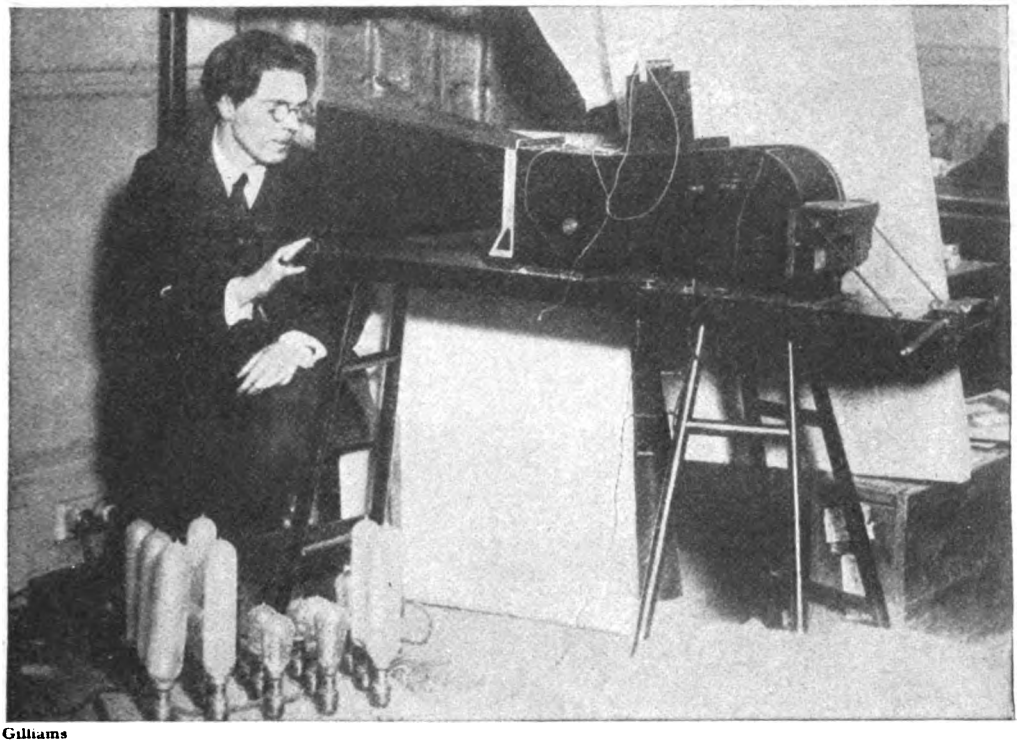

Gilliams

"POWER FOR RUNNING FACTORIES WILL BE SENT BY RADIO"

So states Professor A. M. Low, the distinguished British scientist and engineer. In the February, 1924, issue of POPULAR RADIO *he described some of the future possibilities of radio—among them the promise of power transmission over directed beams of radio waves.*

miles of unknown Polar Sea just north of Alaska. Other work will consist chiefly of scientific investigation of the aurora and of terrestrial electromagnetic phenomena peculiar to the far north.

One look at the globe shows that the land area and population of the earth are mostly concentrated about its northern axis. Of the nearly two billion people in the world about 1,500,000,000, or seventy-five percent of the whole number, are clustered on the upper portion of the ball on which we live.

Hence, if new land is discovered this summer in that huge blank space that the map shows beyond Point Barrow, that land will be remarkably well situated for easy broadcasting to at least seventy-five percent of the population of the earth. It promises to become a world-relay point, like the present relay station at Hastings, Nebraska.

Two important facts indicate that world-wide broadcasting from such a central station in the Arctic is by no means a flight of fancy:

First, it has been unofficially announced that at the next International Radio Congress plans for a world-wide musical program within a certain narrow band of wavelengths will be seriously considered:

Second, the "Listeners' Vote Contest" polled by the Chicago stations WJAZ, KYW and WDAP, indicates that music is the overwhelmingly popular choice of their vast invisible audience; out of 263,410 votes received, over seventy-five percent demanded a daily diet of music.

But new land in the Polar Sea will mean far more than just a possible

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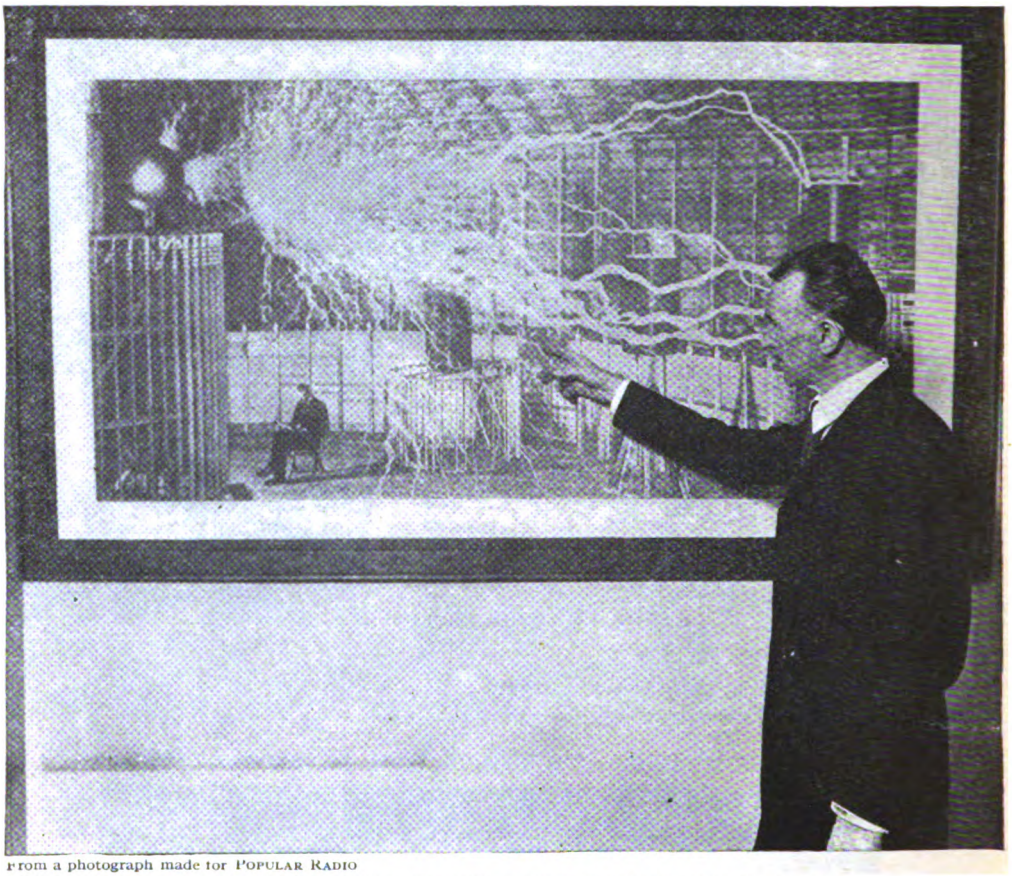

From a photograph made for POPULAR RADIO

THE MAN WHO FIRST SENT POWER BY RADIO

Back in 1900 Nikola Tesla not only produced electric discharges thousands of times more powerful than any produced before, but he sent power enough to light electric lamps, by radio, at distances of hundreds of feet. Only the lack of a way of directing the beams of radio power in a single direction prevented the development at that time of practical methods of power transmission without wires. This problem of directed radio beams is now in a fair way to be solved.

location for a broadcasting station.

There was a period, millions of years ago in geologic history, when a moist and torrid climate prevailed not only in the tropics but at the Poles as well. Dank vegetation covered lands where ice-caps now climb thousands of feet into the sky.

With the passing of time this vegetation became buried; then was metamorphosed by heat and pressure into coal and oil. Sledging through Ellsemere Land a thousand miles north of the tree line MacMillan and I found naked seams of fine black coal exposed. The navy has a vast oil reserve in north Alaska which contains a lake of almost pure vaseline.

The land which Amundsen may discover on his transpolar flight in July will undoubtedly hold even greater deposits of raw fuel. But, hemmed in as it will be by a vast desert of ice, that fuel can never reach a market as such. Nor, for the same reason, can it ever be converted into ordinary forms of electric energy, such as could be conducted by wire to the mainland. The ever-shifting ice pack forbids any such man-made expedient.

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Radio provides the only answer. Incalculable power won from the enormous fuel deposits of the frozen north can be made available to civilization only through the medium of radio power conveyance.

We must not be too skeptical of this hope. Edison, with all his optimism, is alleged once to have denied vigorously that we could ever carry electric current from distant water-power to our cities. Now California is a network of high-tension lines.

Indeed, we may be already in sight of the goal of radio power. Recent experiments with high frequencies, 300 kilocycles and over, have given phenomenal results. On wavelengths under 200 meters, and with absurdly small power, amateur stations have covered distances beyond the range of all but the largest professional sets. It is reported that regular daylight transmission between Paris and Nice has been obtained on a wavelength of 56 meters, or about 5,500 kilocycles. Marconi has gone beyond 100 miles by telephone at a wavelength of 15 meters, a frequency close to 20,000 kilocycles.

It is here that we cross the trail to future arctic power transmission. For Marconi has built a parabolic reflector which, with such wavelengths, confines their energy to a very much smaller beam. Indeed, he has thereby reduced the usual 360-degree spread of radiated waves to the almost miraculously small sector of 3 degrees.

In like vein we may imagine radio engineers developing, either by high frequency or by some other means, a radiant kinetic energy capable of being transmitted without appreciable loss from a distant source of power to a suitable receiving station close to civilization. At the latter point will be located some form of transformer for converting the incoming torrent of high-pressure waves into usable power, just as is now done with high-tension currents brought from the high Sierras to the great agricultural valleys of the Pacific Coast.

In still another way north-polar physics, as they concern radio, command attention. Remember that our earth is an oblate spheroid, a ball slightly flattened at its poles. For the same reason —centrifugal force—the atmosphere is tremendously more oblate. Near the poles its depth is many times less than at the equator, a fact that may help to explain the mysterious aurora borealis.

It has even been suggested that the aurora is the manifestation of a natural power just as a waterfall is the visible sign of water-power.

In any event the departure of these radio-equipped expeditions northward this summer is a matter of substantial importance to radio science. Not only may an entirely new field of work be opened up, but study of the radio conditions in high latitudes—such as MacMillan has been in this winter—may lead us to understand riddles that still baffle the Marconis of the world.

A New Series of Articles by Sir Oliver Lodge

ENGLAND'S *foremost physicist, whose writings on radio and electrical phenomena have appeared in this magazine during the past two years, has just completed another important series that has been written especially for the radio amateur, and which will appear exclusively in* POPULAR RADIO—*beginning in an early issue.*

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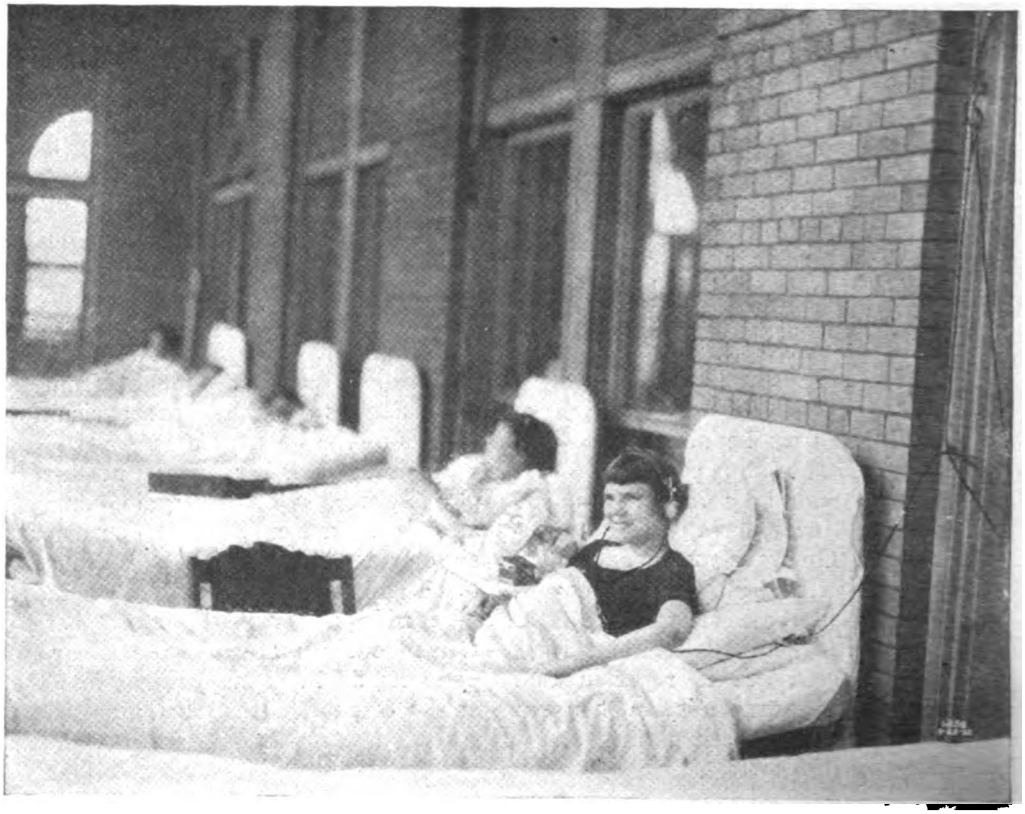

A HEADPHONE TO EVERY SICKBED

Every one of more than five hundred beds in the three Pittsburgh tuberculosis hospitals is equipped with a radio headset, so that any patient may listen in at any time without disturbing the neighbors.

Dr. Radio, Interne

An order has just gone out to equip all beds in all Government hospitals with radio headsets. How this unusual form of installation works in actual practice has been successfully demonstrated by the hospitals in Pittsburgh—and is told in the following article.

By HARRY A. MOUNT

IT was at Station WCAE, Pittsburgh. The singer was an experienced concert artist, but it was her first radio "appearance." As the announcer introduced her and the piano accompaniment began her hands trembled so that the music sheets she held shook. Her voice was weak and strained. It not infrequently happens that the most experienced singers experience this new form of stagefright when first they face the microphone in the deadened interior of a radio studio. When the singer had finished the number she sank into a chair.

"Oh!" she said. "That was the most awful experience I have ever had."

Luckily she was given a chance to compose herself, for another artist went "on the air" for a few minutes. We

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stepped out of the studio into the reception room to wait.

"It's uncanny," she said. "If I could only see or hear my audience or just had some sort of a picture of them in my mind."

"I'll give you a picture of part of your audience," I volunteered. "Just imagine a long row of white beds in a screened room; on each pillow a white face. But there are smiles, for at the head of each bed a pair of radio telephones are attached and most of them are in use."

That day I had visited most of the large hospitals in Pittsburgh and I assured her that the sound of her voice eased no less than five hundred beds of pain that night, and perhaps a thousand, in hospitals of Pittsburgh alone.

Nearly every hospital in the city has radio equipment of some kind. Most of it has been donated. There is also probably the most complete hospital radio equipment in the world in the three city-owned tuberculosis hospitals. Each bed (and there are more than five hundred) has, as part of its permanent equipment, a pair of telephone head receivers.

The equipment in each of the two smaller of these hospitals consists of a single radio receiving set installed in the basement. Batteries, charger, and a power amplifier are part of this equipment. From this set run wires to all parts of the buildings. One of the patients is trained as operator and it is his duty to keep the set running day and night, whenever there is anything to

OLD DR. RADIO IN THE CONVALESCENT WARD

Every afternoon and evening the men patients in the ward maintained by the Carnegie Steel Company in St. Elizabeth's Hospital in Pittsburgh are entertained by a different sort of ether wave than that to which patients are ordinarily accustomed.

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be heard. The patients may listen in at any time merely by placing the telephones on their ears. In addition there is a loudspeaker which can be moved to any part of the buildings for special uses.

Twice a week there is a movie show for the patients and the loudspeaker furnishes music; it is used in the schoolroom for the little patients; occasionally, when requested, it is placed in one of the wards so that all of the patients may hear without the headphones. Again it furnishes an evening's entertainment for the doctors or nurses. The largest of the tuberculosis hospitals has two receiving sets and three loudspeakers, beside the headphones.

The proposal to install this radio equipment in the tuberculosis hospitals met with strenuous official objection at first, but, chiefly because part of the equipment had already been ordered, one of the smaller hospitals was equipped as an experiment. Now all are equipped —and no one is better pleased than the official who originally made objections.

"I think if anyone tried to take the radio out now," said one of the doctors, "we would have a mutiny on our hands."

There had been ample ground for the official objection too. In Pittsburgh, as in most other cities, there are a number of hospital installations which cannot be counted successful. In several instances expensive sets have been donated to the hospital with only a loudspeaker for receiving; such an outfit can seldom be used in a ward. If one of the patients is too ill to listen, all must forego the pleasure of doing so.

But there are exceptions.

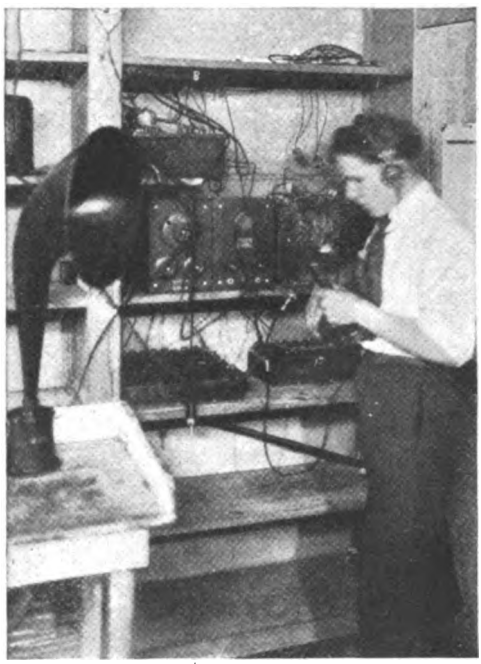
At St. Elizabeth's Hospital the Carnegie Steel Company maintains an industrial ward and the company has installed, in a sun room, a fine radio receiving outfit with a loudspeaker. Most of the patients are convalescent from accidents and the radio is kept busy nearly every minute of the day.

The receiving apparatus in this case is enclosed in a glass-front case which is kept locked. The hospital electrician has the key and he makes the necessary adjustments. There is a switch on the outside of the cabinet so that the patients can turn the set on and off.

It is important that the patients should not be allowed free access to the receiving apparatus.

"Yes," said the superintendent of one large hospital, "we have a fine radio set, but the patients break so many parts the upkeep is too much. I am letting them go without it for a while."

In another hospital a fine radio set had been installed in the chapel, where it was used only on Sunday morning to receive broadcast church services. Someone had "borrowed" a couple of the vacuum tubes, the batteries had run



THE RECEIVING APPARATUS

The receiving apparatus and power amplifier that serves the three Pittsburgh tuberculosis hospitals is located in a basement room; from this set wires lead to all parts of the buildings. One of the patients is trained as an operator and no one else is allowed to touch the apparatus. The telephone transmitter is used to make announcements to the patients between numbers.

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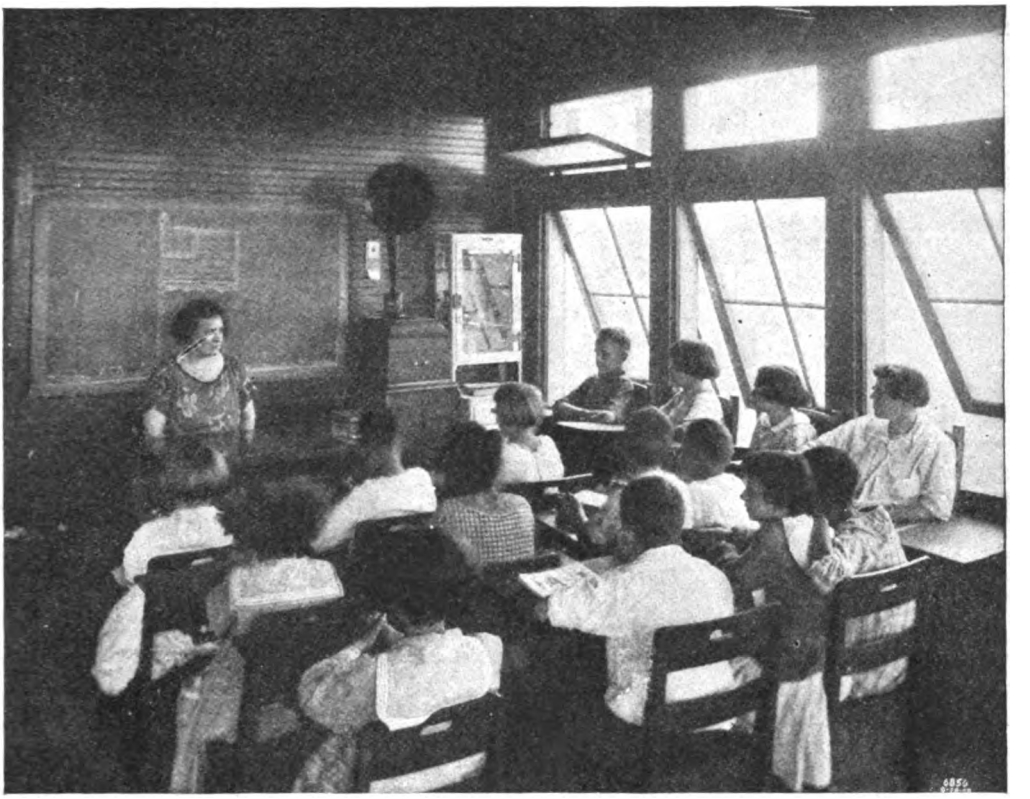

The little tubercular patients who attend school at the Bedford Farms Hospital in Pittsburgh can either go out and play between lessons—or listen in on radio.

down and it was useless. It could not be moved from the chapel for fear of offending the donor.

At the Marine Hospital there is a radio set in the Red Cross hut, and it not only furnishes nightly entertainment for a group of disabled veterans of the World War, but music for frequent dances.

Aside from the radio sets owned by the hospitals, every institution visited had from one to five patients who had had their own radio sets installed at their bedside.

"And so," I said to the singer, "you may be sure that at least five hundred sick folks, all over Pittsburgh, are hearing your voice when you sing."

At that moment the studio director summoned her for her second number. I went to the operating room to hear how her voice "came through" this time. It was strong and clear. I looked through the glass door into the studio—not a sign of nerves!

"I was singing for *them*," she said, when she came back into the reception room.

The telephone bell rang and one of the studio attendants answered. He called the singer.

"One of the patients at the Bedford Farms Tuberculosis hospital would like to speak to you," he said.

Radio in Every Room!

Some day our homes, hotels, clubs, hospitals and other buildings will be wired for radio as they are wired for electric lights and telephones today. Read about it in POPULAR RADIO—*for July.*

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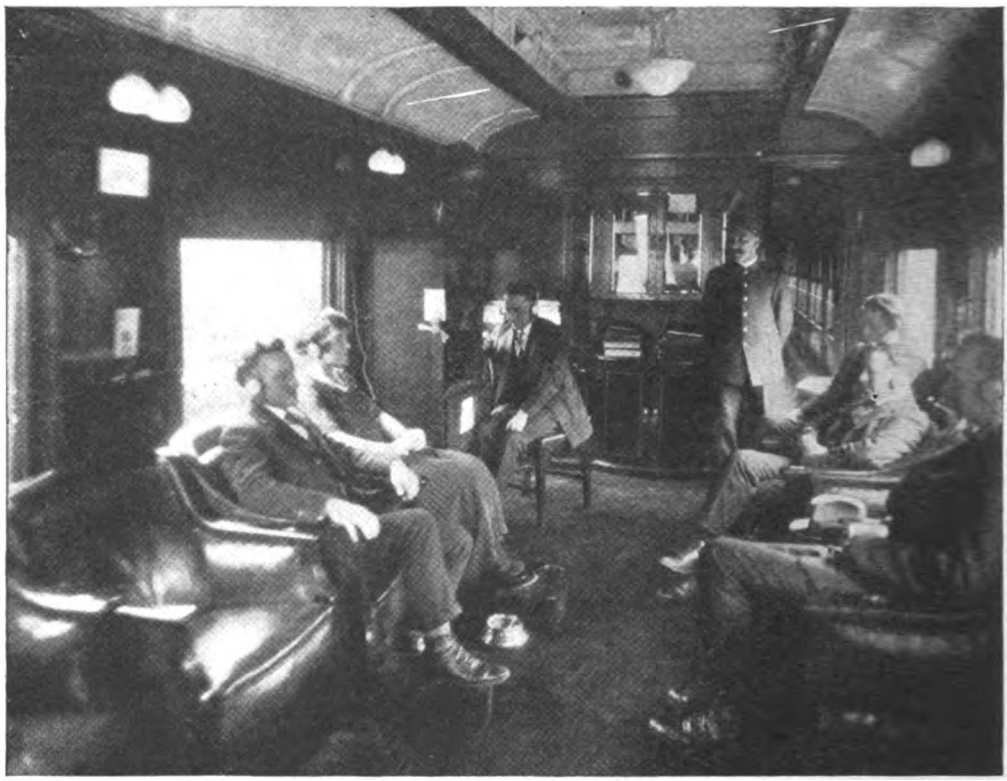

A RECEIVING SET ON A MOVING TRAIN

One of the unusual uses to which the railroad company is putting radio is to enable its passengers to listen in while traveling. Many of its transcontinental trains are already equipped with receiving sets—with one loudspeaker and twelve pairs of headphones to a car.

A Railroad Rides the Ether Waves

The unique and significant experiment that is being made for bringing half a continent within a proposed radio net.

By J. M. McMULLEN

ONE of the most remarkable experiments ever attempted with radio has recently been announced by the Canadian National Railways, whose 140,000 employees are scattered from the Gulf of St. Lawrence to Vancouver and from the Great Lakes to Hudson Bay. According to Sir Henry Thornton, president of the railroad, radio will be used for keeping this army of workers in touch with the plans and policies of the management through the medium of 140,000 receiving sets—one to every employee—and a chain of broadcasting stations.

The technical problems of this unique program are under the supervision of Vice-president W. G. Robb, who has created a special radio engineering department to handle the undertaking. No

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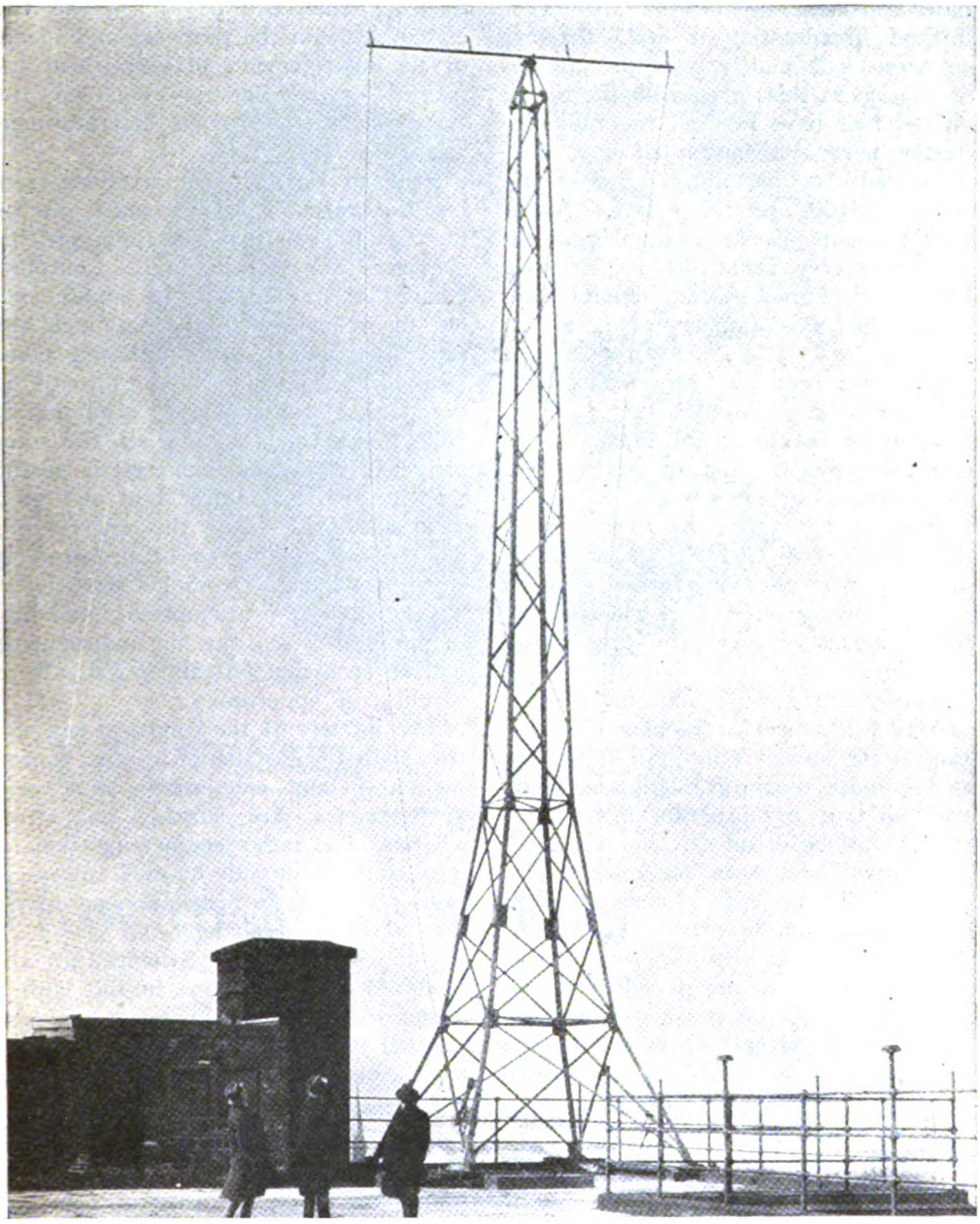

One Link in the Proposed Chain of Broadcasting Stations

This is station CKCH, which is now nearing completion; it is claimed to be the most powerful station in Canada. It is located in Ottawa and will be operated by the Canadian National Railways as one of a contemplated chain of stations. The antenna towers are 155 feet apart and stand 300 feet above the ground.

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other business organization has ever utilized broadcasting to weld together so large and widely scattered an organization as this; even with the titanic strides that have marked the radio industry never has any plan been contemplated for installing at a single stroke 140,000 receiving sets. A recent estimate placed the number of receiving sets in Canada at 100,000; the plan of the Canadian National Railways will double this number within a few months.

The plan provides for establishing a chain of radio broadcasting stations from coast to coast; for equipping all transcontinental trains on the system to receive radio programs; for installing radio receiving sets in all hotels owned or controlled by the company and for perfecting a scheme whereby radio receiving sets will be placed within the means of every employee of the company.

The railroad now has under construction a powerful broadcasting station in Ottawa. This station will be tied in with the large station at Montreal so that any program from either station can be broadcast simultaneously and heard throughout the eastern part of Canada. After the completion of the Ottawa station other stations will be established at such intervals across the continent that the president of the railroad will find it possible to address all of his employees at one time. It is his opinion that he should broadcast talks to his men in their homes at least once a week, and that other officials should send messages to them by the same route in the meantime. The aim of these talks will be to acquaint the employees with the purposes and ideals of the management, to keep them informed of any developments on the system, and to provide entertainment and education.

How to put 140,000 receiving sets into the homes of the workers is one of the big problems that Mr. Robb and his engineers are working out. Complete details still remain to be announced, but the scheme will take on much the same form as the stock-purchasing plans used on a number of the railroads in the United States. For example, if John Smith wants a radio set, the company will take enough interest in seeing that he gets it to offer him one at a wholesale price—with the understanding that its cost is to be deducted in small installments from his pay check. There will be no attempt to force him to purchase a set; but the inducements will be such that he cannot well afford to miss the opportunity.

The interest of the company will not stop with the installation of the receiving sets in the homes of its employees; arrangements are already in effect whereby the radio engineering department answers directly by mail any questions pertaining to installation or operation of radio receiving sets.

But of special importance to the thousands of radio fans in the United States who spend a portion of the year hunting or fishing in Canada, this announcement means that the time is not far distant when even with a portable receiving outfit visitors to the "wilds of Canada" will be able to listen in on the radio world.

An Efficient Two-tube Receiver for $45.00

To MEET *the demand for a popular-priced radio set that will meet the needs of the average broadcast listener who wants clarity of reception combined with reasonable distance,* POPULAR RADIO *has developed a simple and easy-to-make receiver that is regarded by experts as a distinct step forward in the design of the two-tube set. It will be described in detail in another of the popular "how-to build" articles—in the August number.*

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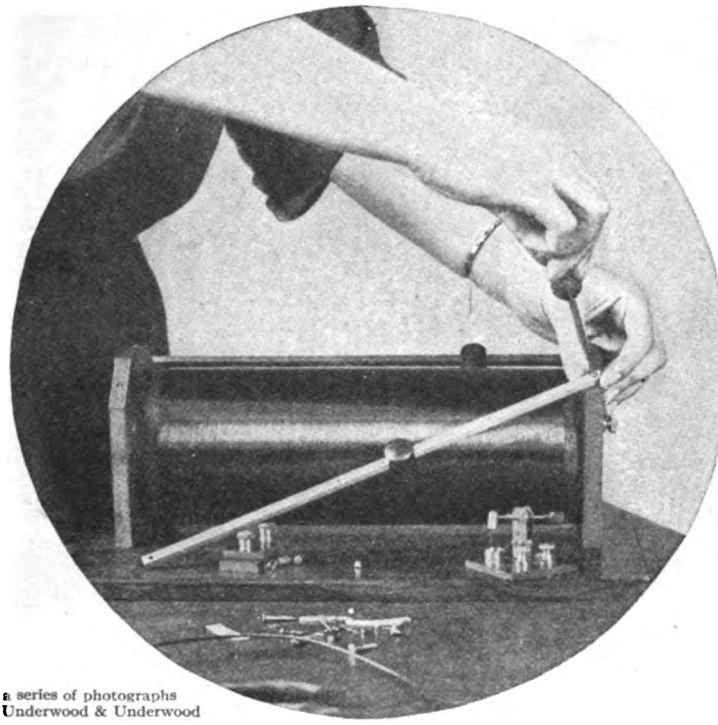

From a series of photographs
© by Underwood & Underwood

PUTTING ON THE SLIDERS

1 *After winding a ten-inch section of No. 26 enameled wire on a tube 3½ inches in diameter and fastening the tube to two wooden ends and a base, the tuner should be fitted with two slider rods and two sliding contacts. These are fastened with two screws each to the wooden ends.*

How to Make a Two-slide Tuner

—told in pictures

FROM England comes this interesting series of pictures; with the accompanying explanatory instructions they should enable the novice to assemble a small crystal receiver that will cover a wide range of wavelengths and enable him to "pick up" all the broadcasting and government stations in his vicinity within a range of fifteen miles. The captions tell how to do it and the pictures show the different operations and the results.

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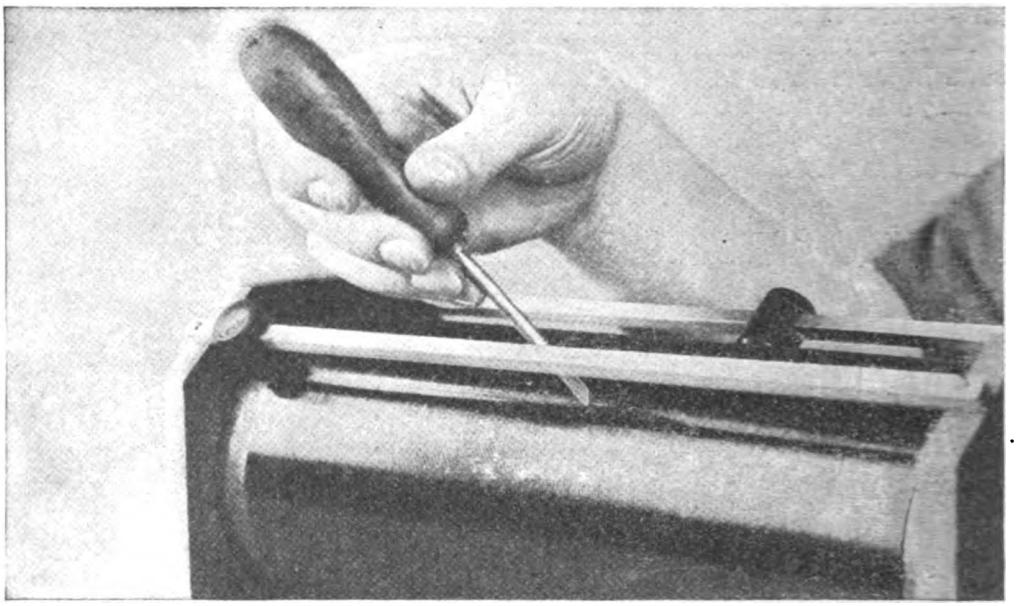
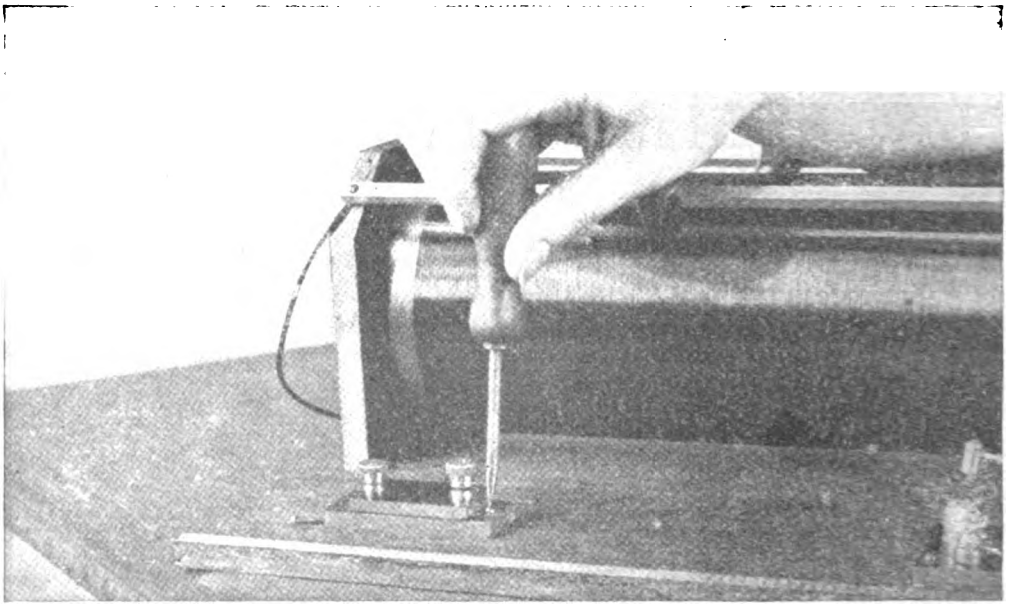


HOW TO PREPARE THE CONTACT PATH FOR THE SLIDERS

2 *With a sharp screw-driver scrape away the enamel coating on the wires in the path of the sliders so that the sliders can make proper contact with the individual wires.*



HOW TO FASTEN THE TELEPHONE CONDENSER IN PLACE

3 *Next, place the fixed telephone condenser on the wooden base in a convenient position and connect the end of the slider rod to the left-hand binding post with a piece of wire.*

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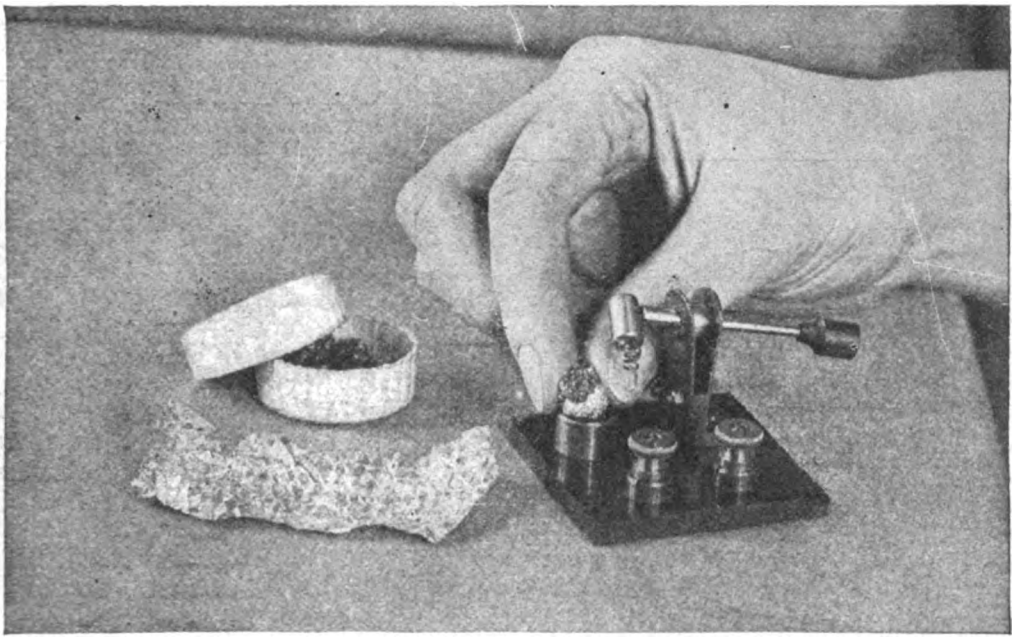
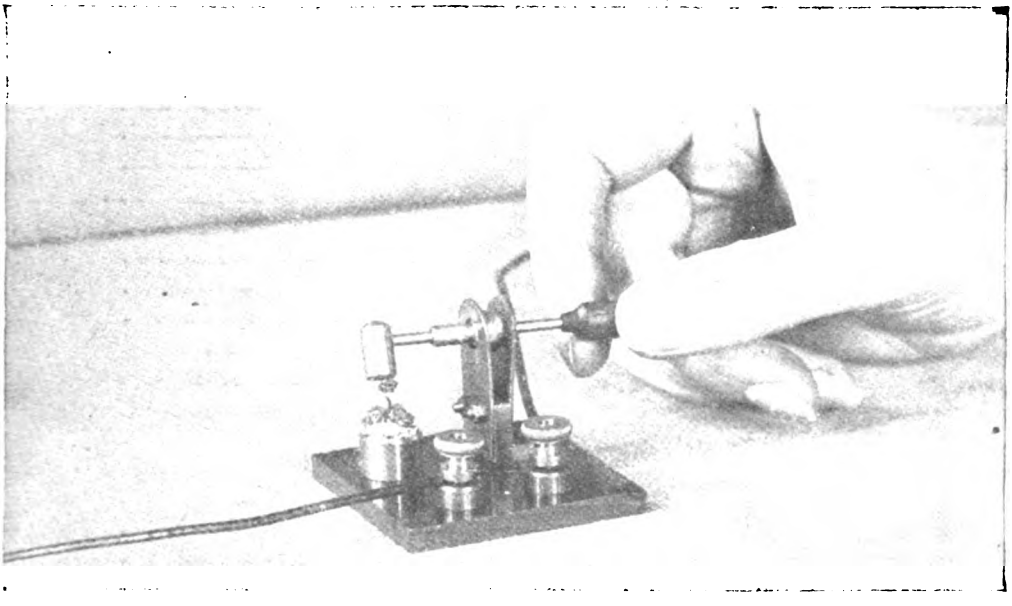


4 PUTTING THE MINERAL IN THE DETECTOR
Place a piece of galena or some other crystal in the detector cup and make it fast.



5 HOW TO ADJUST THE DETECTOR
The crystal detector is fitted with an adjusting arm with which the sensitive spot on the crystal is located when the set is placed in operation.

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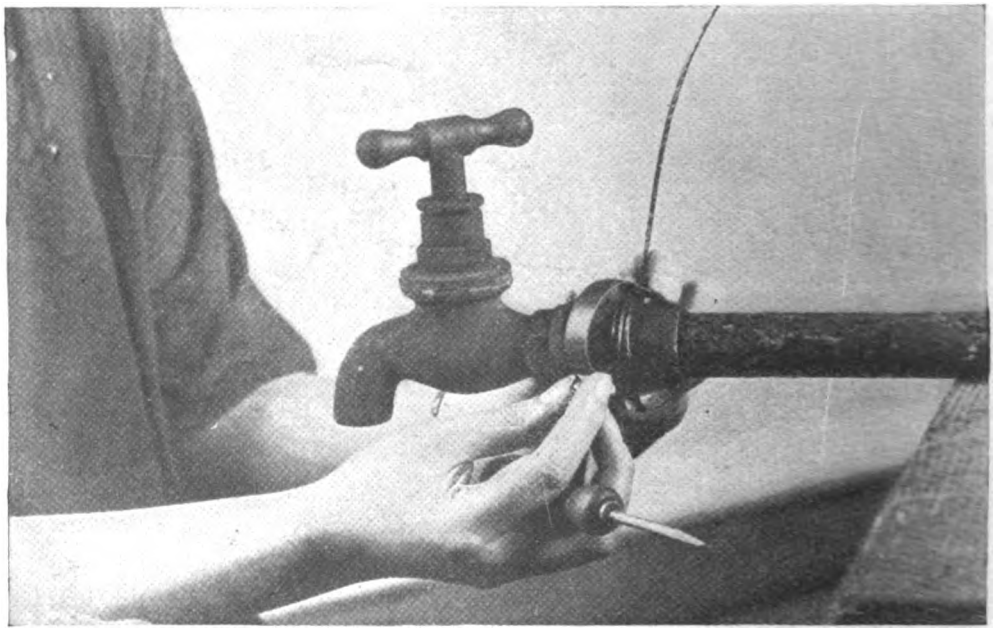
HOW TO MOUNT THE DETECTOR

6 *The detector is then screwed to the wooden base at the right of the set so that it will be convenient to adjust with the right hand, while tuning the set with the left hand.*

FASTENING THE GROUND WIRE

7 *A wire is fastened on the water pipe and run to the set and fastened to the binding post shown in (11) which is in turn connected to the right-hand end of the coil of wire on the tuner, and to the right-hand binding post of the detector.*



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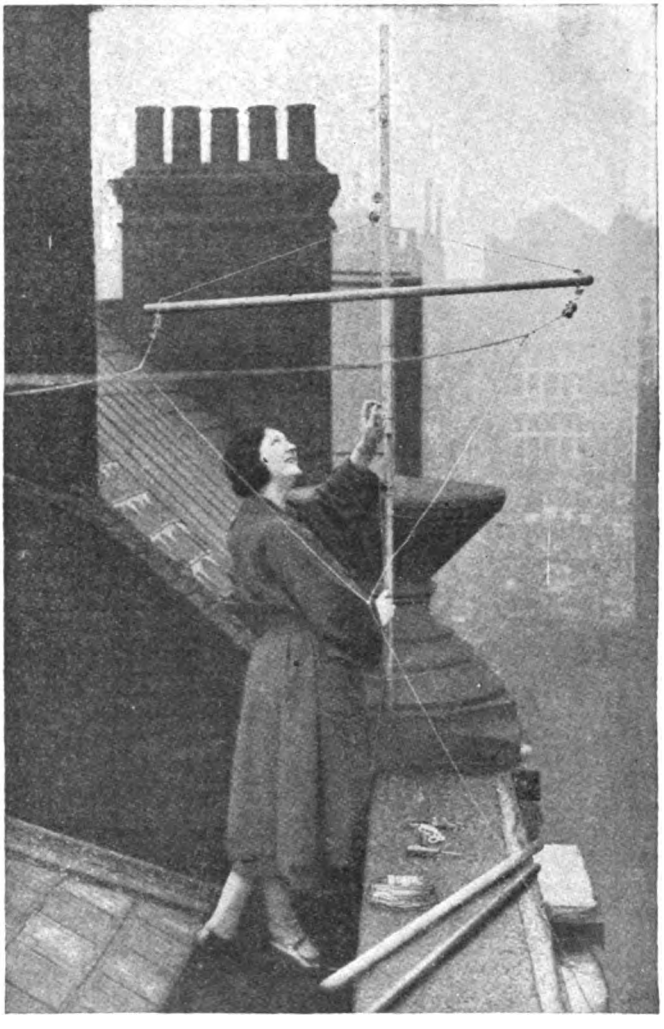
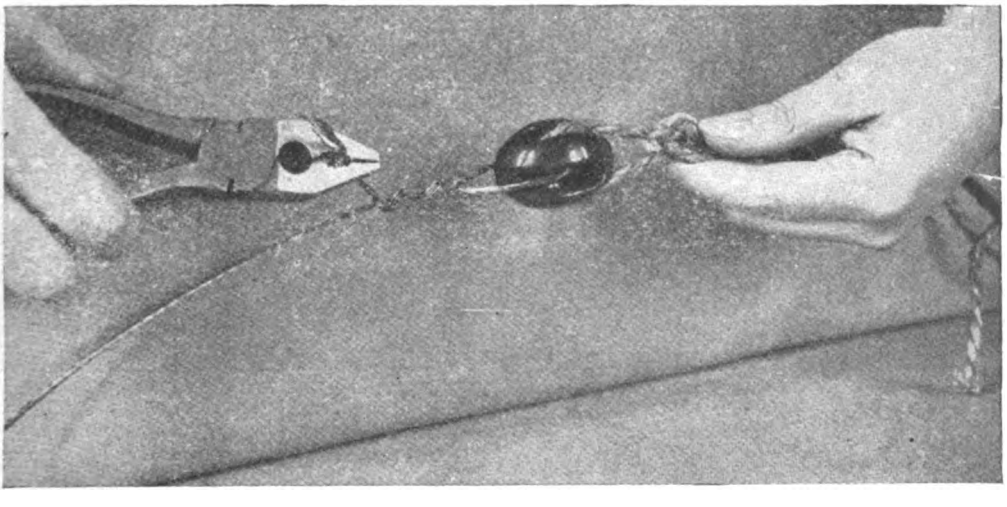
ERECTING THE ANTENNA

8 *A two-wire antenna with insulators on each end and using an old broomstick for the spreaders should do the trick. The lead-in wire should be connected to both wires and run down over the side of the roof.*



HOW TO STRING THE INSULATORS

9 *The wires should be fastened to the insulators with a rope connected to the insulator for attachment to the spreaders.*



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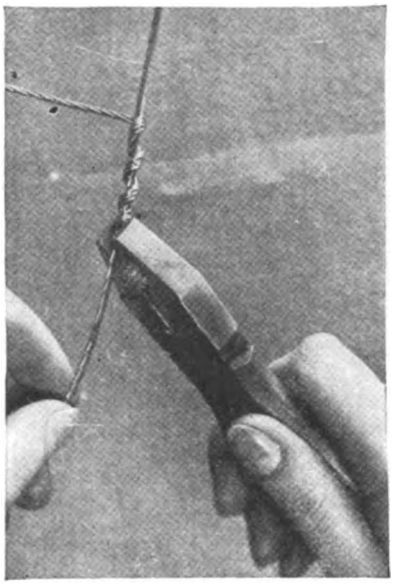
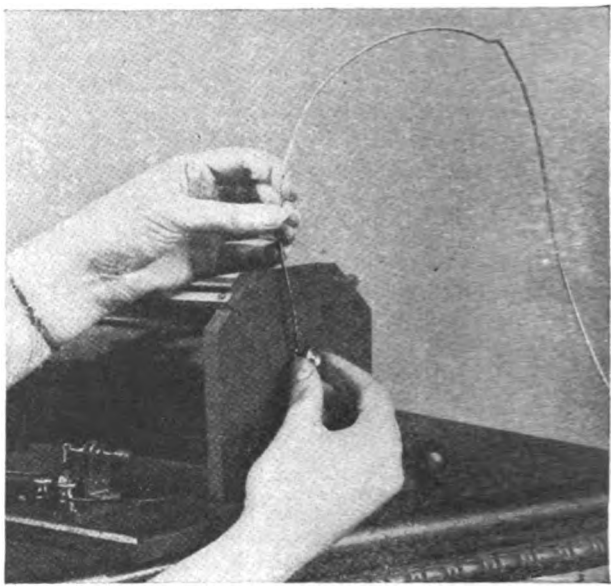


HOW TO JOIN THE WIRES

10 *Wrap the lead-in wires around the antenna wires securely (with a pair of pincers) and then solder them together.*



CONNECTING UP THE GROUND WIRE

11 *This was explained in Figure 7. The antenna lead-in wire should be connected to the rear slider rod.*

TUNING IN

12 *After the telephones have been connected across the telephone condenser, and the right-hand binding post of the condenser connected to the left-hand binding post of the detector, the set is ready for use. Tuning is done by "pushing the sliders."*

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Catching Radio Waves on the Trap Lines

By H. F. MULLETT

UP north, among the lonely spruce woods of the Canadian Northwest and a hundred miles from the nearest city, is a little log cabin occupied by Eldon Lockhart and Felix Calma.

But overhead among the tall timber that almost shuts out the blue skyline there is a thin wire line, forty feet in the air, with ends inside the log building, connecting with a radio receiving set that was built by Lockhart, without previous experience. A turn of the knob—and the solitudes are peopled by the magic of voices and the lilt of a thousand instruments. A whole world of news and music stands just outside that lonely cabin door!

Lockhart is twenty-one. He traps in the winter, and studies land surveying in the long winter evenings—when he isn't listening in over his radio set.

It was out on a Saskatchewan homestead that Lockhart first got his liking for the radio. He listened in on a small crystal set, filled with enthusiasm for this wonderful thing that was to end his solitude. "I'll have one of those sets this winter when I go out on the trap line," was his thought.

So, when he went into the woods, Lockhart carried with him, in addition to his outfit of steel traps, blankets, rifle, and grub, a diagram of a single-circuit regenerative receiver and the parts. He had never examined a tube-set before, and in putting his set together he blew out his WD-11 tube. This caused a month's loss and some long trips back to the nearest mail point from which a letter could be sent.

However, the set was all ready at last, and the two trappers, both unused to fishing for wavelengths, listened in, quite appalled at the howls and screams that filled the little cabin. More turning of dials, and the delighted amateurs heard:

"This is station KGW, of Portland, Oregon."

Since then, they have picked up over sixty stations.

This spring, the Canadian government will install a $50,000 sending set at Edmonton, the capital of Alberta, and will equip police posts in the northland with receiving sets. From Edmonton to the Arctic Ocean—over two thousand miles of rough territory, inhabited only by a few white men, trappers, traders, prospectors and police, and by bands of wandering Indians and Eskimo—radio waves will be sent out to end forever the solitude of that vast wilderness.

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HOW TO CALCULATE THE

WIRING OF COILS

ARTICLE No. 3 of a new series of short articles that contain useful facts—summarized for your notebook. This installment tells about the sizes and resistance of wire used in radio work.

By E. E. FREE, PH.D.

WHEN a wire is referred to by a certain number, as, for example, "No. 16 or No. 28," this number means the "gauge" of the wire. It is a way of specifying the thickness. It would be much more convenient and scientific simply to set down the diameter of the wire in thousandths of an inch or in millimeters, but years ago engineers got into the habit of specifying the sizes of wires and rods and plates by the particular slot or hole in a "gauge plate" into which the wire or other thing would fit. The habit has persisted. These slots or holes were numbered, hence the present numbers used to designate the sizes of wire.

Many such systems of gauges have been in use in different countries and at different times. In the United States, for use with copper wire, only one of these systems has survived. This is the American Standard or "Brown and Sharpe" gauge, often referred to as the "B. and S." gauge. The numbers in it are purely arbitrary, like the width letters for shoes. The gauge numbers do have, however, a mathematical relation to each other such that an increase of three numbers means a decrease of the cross-section of the wire by just one-half; which means, in turn, a doubling of the electrical resistance of each foot of the wire.

It is useless, however, to bother about remembering this mathematical relation. The table printed with this article gives the numbers in the Brown and Sharpe gauge, with the diameters of the wires in "mils," one mil being one thousandth of an inch. In this table, for example, number 18 wire is seen to have a diameter of 40 mils, which means that its thickness is 40 thousandths, or one twenty-fifth of an inch.

In many of the books you will see tables of "circular mils." This is the *square* of the diameter of the wire in mils. For example, number 18 wire equals, in circular mils, the square of

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40, or 1,600. Note that this is *not* the area of the cross-section of the wire, for the wire is circular instead of square and the area of its cross-section is not the square of its diameter but must be calculated from the geometrical formula for the area of a circle.

Fortunately the possible confusion about the circular mils has little importance in radio calculations as circular mils are not much used by radio writers. The best thing to do is to use always the *diameter* of the wire in mils. If figures are given in circular mils take the square-roots of the numbers and you will have, in all cases, the diameters of the wires in mils.

The electrical resistance of a copper wire depends on its cross-section. In the table are given the resistances of wires of the different gauge numbers for direct current at ordinary room temperatures. In practice these resistances must be considered merely as approximate values, since the resistance of wire varies slightly with the hardness or softness of the wire, with the temperature and sometimes with other things. The figures in the table are close enough for all ordinary purposes.

Bear in mind that these resistances are for *direct* current. For ordinary alternating currents, such as are used in power work or in house lighting, the resistances are about the same, but for radio-frequency currents the resistances are quite different because of the skin effect. It is impossible to give a general table for resistances at radio frequencies since the frequency, the nature of the winding, the character of insulation on the wire, the tube that it is wound on and even other factors, may affect the measured resistance of a coil.

THE SIZES AND PROPERTIES OF DIFFERENT KINDS OF COPPER WIRE

B. & S. Gauge	*Diam. Mils.*	*Feet Per Pound*	*Ohms Per Foot*	*TURNS PER INCH*			
				Bare	*S.C.C.*	*D.S.C.*	*Enameled*
8	128	20	.00064	7.8	7.3	....	7.7
9	114	25	.0008	8.7	8.2	....	8.6
10	102	32	.0010	9.8	9.2	....	9.6
11	91	40	.0013	11.0	10.3	....	10.8
12	81	50	.0016	12.3	11.5	....	12.1
13	72	63	.0020	13.8	12.8	....	13.5
14	64	80	.0026	15.6	14.3	....	15.1
15	57	100	.0033	17.5	15.9	....	16.9
16	51	127	.0041	19.6	17.9	18.3	18.9
17	45	160	.0052	22.2	20.0	20.4	21.3
18	40	200	.0065	25.0	22.2	22.7	23.8
19	36	260	.0082	27.7	24.4	25.2	26.5
20	32	320	.0104	31.2	27.0	28.0	29.7
21	28.5	408	.0131	35.1	29.9	31.0	33.1
22	25.3	515	.0165	39.5	33.9	34.4	37.2
23	22.6	650	.0208	44.2	37.6	37.9	41.5
24	20.1	820	.0262	49.7	41.5	41.8	46.5
25	17.9	1,030	.0330	55.8	45.7	46.1	52.1
26	15.9	1,300	.0416	62.8	50.2	50.8	58.5
27	14.2	1,640	.0525	70	55	55	65
28	12.6	2,060	.0662	79	60	61	73
29	11.3	2,600	.0834	88	65	66	82
30	10.0	3,280	.105	100	71	72	91
31	8.9	4,140	.133	112	77	78	103
32	8.0	5,230	.167	125	83	84	115
33	7.1	6,570	.211	140	90	91	130
34	6.3	8,330	.266	158	97	99	145
35	5.6	10,480	.335	178	104	106	161
36	5.0	13,200	.423	200	111	114	180
37	4.5	16,600	.533	222	118	121	204
38	4.0	21,000	.673	250	125	128	227
39	3.5	26,500	.848	285	135	137	256
40	3.1	33,400	1.070	322	141	145	286

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For use in winding coils and in calculating the amount of wire needed for them the tables of turns per inch will be found useful. This means linear inch, along the coil, one layer deep. The figures are approximate only, as the wire made by different manufacturers differs slightly. "SCC" means "single-cotton-covered;" that is, a wire wrapped with one layer of cotton insulation. Similarly, "DSC" means "double-silk-covered" wire, having two layers of silk insulation. There are also "double-cotton-covered" and "single-silk-covered" wires but they are little used in radio work. Enameled wire, having a thinner and transparent insulation, is much used in radio.

Wires of unusual shape, as, for example, square bus-wire, are usually specified by the number of the round wire to which they are equivalent in electrical resistance. This means that such wires have the number of the round wire having the same cross-section. A number 16 bus-wire, which is a common size for wiring radio sets, has as much copper in it per foot as has a number 16 round wire. There will be, therefore, about 1,275 feet of such wire in a pound.

In England an entirely different set of gauge numbers is sometimes used for wires. It is called the "British Imperial Standard Wire Gauge," frequently abbreviated to "S. W. G." A few British publications use the Brown and Sharpe gauge just as we do, but if the gauge system is not specified it is safe to assume, in British work, that the S. W. G. system has been used. This system is also used more or less in other countries, though in France it is customary to specify, also, the diameter of the wire in millimeters. A millimeter is one thousandth of a meter or about .04 inch. One millimeter equals 39.37 mils, and one mil equals .0254 millimeter. These figures permit easy conversion of either one into the other.

The B. and S. gauge, the S. W. G. system, the measurement in mils and the similar measurement in millimeters are the only four ways commonly used to specify the size of copper wires. But for iron and steel wires three other gauges are sometimes used; the Roebling gauge (also called the Washburn and Moen gauge), the Birmingham gauge and the Stubs steel-wire gauge. The Stubs *iron-wire* gauge (as contrasted with that for steel wire) is the same as the Birmingham gauge. All this is rather complicated but it has, fortunately, little application to radio as these gauges are not used for copper wires.

The approximate relations between the two gauges that are used for copper wires are given in the following table:

No. 10 S.W.G. (British) equals No. 8 B. and S. (American)
No. 14 S.W.G. (British) equals No. 12 B. and S. (American)
No. 18 S.W.G. (British) equals No. 16 B. and S. (American)
No. 22 S.W.G. (British) equals No. 21 B. and S. (American)
No. 26 S.W.G. (British) equals No. 25 B. and S. (American)
No. 30 S.W.G. (British) equals No. 28 B. and S. (American)
No. 34 S.W.G. (British) equals No. 31 B. and S. (American)
No. 42 S.W.G. (British) equals No. 38 B. and S. (American)

These relations are not exact, but give an idea of the relation between the two gauge systems. For the exact diameters of wires in the two systems, as well as for details concerning exact resistances and the like, it is necessary to consult the more comprehensive tables in the handbooks of electrical engineering.

Save These Articles for Reference!

This series of articles includes statistical tables that are of practical value to the radio experimenter—particularly to the amateur who designs his own sets. The preceding articles of this series include:

"How to Convert Wavelengths into Kilocycles" - *November*, 1923
"How to Make Power Calculations" - - - - - - *March*, 1924

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"THE MONOPOLISTIC CONTROL OF RADIO IS A REALITY"

The author of this article writes from the point of view of the owner of both a broadcasting station (W.L.W.) and of a manufacturer of radio apparatus.

Should There Be a Monopoly of Broadcasting?

How the threatening control of radio stations by one organization may menace the right of free speech.

By POWEL CROSLEY, JR.

WHAT would a monopoly of broadcasting mean to the American public?

The manufacture, sale and license of broadcasting stations is confined entirely to the Western Electric Company—and of course the American Telephone and Telegraph Company—under some agreement that they have made with the other members of the Radio Corporation of America.

It is said that the Westinghouse Electric and Manufacturing Company is permitted to operate three broadcasting stations, probably without limit as to power. The General Electric Company and the Radio Corporation itself reserved the right to operate three broadcasting stations each. The balance of the broadcasting is entirely under the control of the American Telephone and Telegraph Company. Taking the stand that they are, of not permitting any independent broadcaster to utilize more than 500 watts, and being in absolute control of the wire systems to tie together their various stations, the telephone company has what amounts to complete control of the broadcasting situation in this country.

At the same time no limitation as to broadcasting power is to be observed by the telephone company or by the other powerful affiliated organizations.

In perhaps a year, or maybe in five years, they will have developed transmitters with which the owner of a crystal set or its equivalent in San Francisco can hear broadcasting stations in New York City. It is not beyond the realms of possibility. What will happen then?

There will be a few powerful stations in this country controlled by the same organization; censoring every word, curtailing the freedom of speech—that right so dear to the American public. This becomes, then, an actual attack upon the First Amendment of our Constitution, which provides for the right of free speech.

Nor is the question of power the only indication of monopoly. The control of land wires is in the hands of the American Telephone and Telegraph Company. A monopoly of all land telephonic transmission may be necessary for the good of service, yet this same monopoly is imposed upon every inde-

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pendent broadcasting station. Charges for remote control, pick up and for broadcasting can be, and are, set at whatever figure may be desired by the telephone companies.

For example:

When David Lloyd George visited and made a tour of this country, he made a talk in Indianapolis. I desired to broadcast his speech from Station WLW, which necessitated a tie-in by wire from Cincinnati to Indianapolis. I asked the cost and was told that the expense would be $800 for twenty minutes. In the case of President Coolidge's speech in the east, arrangements had been made by the Rotary Clubs of America to have a certain independent broadcasting station in Chicago tie-in by wire so that the people in the mid-west could also hear the message. But no wires were available for the purpose. Here was a case in which the great American public was deprived of the opportunity of listening to the head of their nation.

There should be only one restriction upon a broadcasting station—its inability to render service. No broadcasting station will find it possible to exist for a long time unless it gives the type of programs that the public wants. When a broadcasting station ceases to create "good will," its value to those who maintain it ceases to exist and it becomes a liability instead of an asset.

Of course, it is obvious that the American Telephone and Telegraph Company is not planning to control broadcasting for nothing. It admits that it is better able to handle the job of broadcasting than anyone else. But what will happen if it gets complete control? Will it continue to maintain this service without any charge? No. There is already an organization in New York formed to collect voluntary subscriptions from the public to provide funds to supply talent to the American Telephone and Telegraph Company's stations. As soon as broadcasting is completely controlled, a means will be devised to collect money from the radio listeners so that its stations can be maintained at a profit.

What is the solution of this problem? Shall any organization, no matter how large and powerful, be allowed to dominate the air? Shall it be permitted to exercise the functions of government in regulating broadcasting stations?

If any one is to designate who shall be allowed to broadcast and who shall be allowed to use greater power, should not this function be in the hands of the Government?

The monopolistic control of radio, which now not only threatens but is a reality, is based upon our present patent law. The question is this. Should the purchase and control of patents be allowed to create a monopoly in a thing so vital to every American as is radio broadcasting?

Kadel & Herbert

"The American Telephone and Telegraph Company has not attempted and does not desire a monopoly of broadcasting," is the official statement given out recently by Mr. H. B. Thayer, the president of that company.

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CONDUCTED BY KENDALL BANNING

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Congress Passes the White Radio Bill

A STEP forward in the development of radio in this country was taken by the United States Senate on April 7, when it passed the White Radio Bill—long advocated by POPULAR RADIO—without a single dissenting vote. This action not only establishes the authority of the Government to act in straightening out much of the confusion that has retarded the growth of the radio interests, but tends to lessen materially the dangers that have threatened of a monopoly on broadcasting—as pointed out in the article on page 599 of this issue.

Using the Loop as a Ground

TO the listener who is more concerned with the clarity of reception than with mere distance, the following tip from an amateur in Milford, New Hampshire is of special interest and value:

A water pipe or similar ground connection is the common method of installing receiving sets. It is well known, however, that several insulated wires stretched under the antenna and connected to the ground binding post of the set may be used instead and with excellent results. Such an arrangement is known as a counterpoise, and although always used as a ground by broadcasting stations is little used with receiving sets, mainly owing to the fact that it takes up too much room. With the limited yard space of the city or village dwelling the counterpoise is usually impossible.

As an experiment it occurred to the writer to try a loop (similar to the well-known loop antenna) as a capacity ground for a three-tube, regenerative set. It was made by framing together in the form of a cross, two strips of pine, five feet long. Brass pins or nails can be driven in the outer ends of the strips, about one inch apart, and pointing slightly outward. The wire is then wound on these pins in a spiral, beginning at the inner pin. At least ten or twelve complete turns should be used, which will call for something like 130 or 140 feet. In my case, the wire used was ordinary antenna wire, not insulated.

This loop was placed in a horizontal position in the basement of the house, practically under the set, and supported on a box at a height of about three feet from the cellar bottom. The ground wire running from the set to the water pipe was disconnected, and a lead wire from the loop attached in its place.

Considerable doubt existed in my mind as to the success of the device, but somewhat to my surprise it was found that the stronger stations came in readily and in good volume. The results were so pleasing that a two-point switch was later arranged near the set, so that the set could be grounded on either the loop or water pipe at will by the simple throwing of this switch.

For very distant stations, or with very weak signals, the water-pipe ground is better; but for the nearer stations, the loop is preferred.

The main advantage is the suppression of much, and most of the time, all, of the noise caused by weak "strays" and by the induction hum from light-wires and motors. With this noise eliminated, all signals are heard better, even though they are not as strong.

—A. L. KEYES

"It might be interesting for an experimenter to test two points," adds Mr. Keyes:

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"*First:* Will the loop function as well in a vertical position as in a horizontal, and is there any directional effect when vertical?

"*Second:* Would more wire add to its efficiency?"

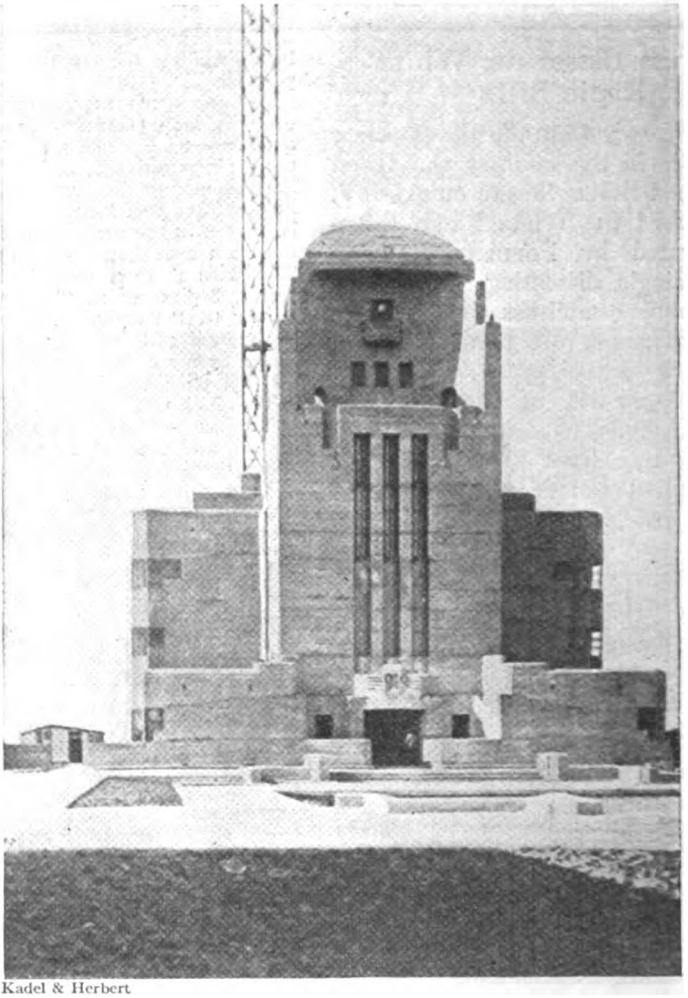
How to Make a Variable Condenser Without a Panel

HERE is a practical little idea from an ingenious radio experimenter; it has the added virtue of being an inexpensive one:

A variable condenser designed for panel mounting can readily be attached to a base-board instead, by means of two brass brackets or corner braces just large enough to hold the condenser clear of the base, when attached to the brackets with the machine screws that come with the instrument. If the lower half of the brackets is attached to the base-board with wood screws, so as to extend back under the condenser, it will be found that a three-inch dial almost obscures the brackets from view. The resulting job is both neat and substantial and is especially satisfactory when testing out a new circuit.

The brackets can be purchased for a few cents at any hardware store.

—DEANE S. KINTNER



Kadel & Herbert

RADIO EVOLVES AN ARCHITECTURE OF ITS OWN

This remarkable structure houses the new radio station at Kootwijk, Holland. It is built of concrete, and a pool of cooling water is located in front of and behind the building.

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Kadel & Herbert

"THE BEST AMATEUR RADIO STATION IN THE UNITED STATES"

Station 9ZT, owned and operated by Don Wallace of Minneapolis, Minnesota, is officially entitled to this appellation by virtue of winning the much-coveted Hoover Cup for 1923. The cup is awarded every year to the amateur station that, in the opinion of the Amateur Radio Relay League, is the most efficient.

These Messages Came in Through the Back Door

THE fact that the longest way round may be the shortest way home, in radio as elsewhere, is illustrated by a report of what happened to some recent messages sent from the American Line steamship *Minnekahda:*

The messages were on commercial business, cleared from the *Minnekahda* as she was steaming east from New York and were sent directly to San Francisco, so that approximately 3,000 miles of distance were covered, overland, in addition to the distance at sea.

The sending operator gave no indication of his reason for transmitting direct to San Francisco, but called the KFS station there directly and went ahead with the matter in the usual fashion. His sending apparatus, the receiving operator said, was heard clearly and sounded like a small arc set. It was supposed in San Francisco that the continous-wave reception stations on the Atlantic coast were busy at the time, and that the business was offered to San Francisco for that reason.

Reception was on an eight-foot loop aerial. The messages were forwarded by land line from San Francisco to their addressees in New York and New Jersey, so that they traveled nearly 7,000 miles to reach destinations only 600 or so miles distant from the sending ship, crossing the continent once by radio and once by telegraph.

Some mystification was expressed by at least one recipient as to the reason for a message from east of New York coming *via* San Francisco.

Although it is not uncommon for vessels to report their positions, when off New York, to the KFS station, so far as known the instance cited is the first of transmission of commercial business from ships in the Atlantic to mainland points by way of San Francisco. The night after these messages were handled, the *Minnekahda* reported her position to San Francisco from a point 915 miles east of Ambrose light, thus establishing communication with a ship's set, over a distance of approximately 4,000 miles, three quarters of which was overland.

—D. R. LANE

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How "Off-stage Noises" Are Made in the Radio Drama

THE popular "radio drama" is apparently becoming established as an institution, and with its development is coming, not only a new crop of radio dramatists and radio actors and actresses, but "off-stage noises" that form such an important feature of the new type of play that appeals to the mind through the ear alone. Here are some of the tricks used in simulating familiar noises.

Did you know that the realistic rain effect you heard during the broadcast production of "The Fortune Hunter" was caused by the rolling of dried peas through a paper tube?

Would it have detracted from your enjoyment of "The Storm" to have known that the forest fire was produced by means of a plumber's gasoline blow torch, the breaking of match sticks and the crushing of paper? The torch produced the effect of rushing wind and flame, and matches and paper, brought close to the microphone, sounded like the crackling of burning tree limbs.

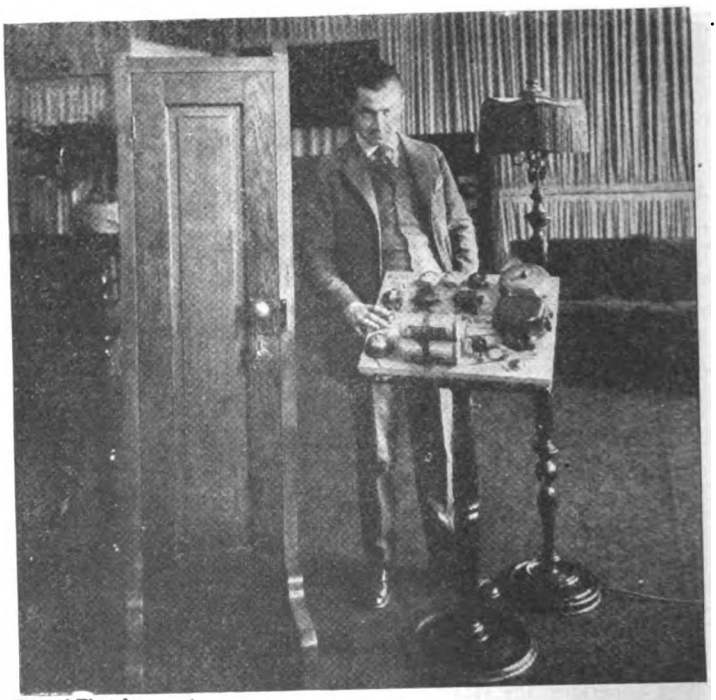
Successful transmission of a dramatic production by radio is dependent upon sound properties. Atmosphere is created and action is simulated by sound, the devices varying with the needs of a particular production.

At Station WGY, where the radio drama has long been a popular weekly feature, special pains are being taken in the preparation of a play for the ether to see that maximum sound results are obtained. Considerable experimenting is necessary to produce the sound desired. Two of the most frequently used sound properties are the door and the bell board.

The bell board consists of a convenient arrangement of five bells of different tones and a buzzer. All are connected to dry cells and may be operated by the pressure of a button. There are door bell, telephone bell, an alarm bell which may be sounded for fire, ambulance or as a burglar alarm. A clock chime is in the group, as is a tap bell.

Probably no property is more important than the portable door and door frame, for it is only by the closing of the door, in interior scenes, that the entrance or the exit of a character may be conveyed to the radio listener. The door is one of the peculiar conventions of the radio drama. Whereas in the home a softly closing door is considered desirable, it is quite important in the radio drama that the sound of the door and clicking of the lock be loud enough to actuate the microphone. The WGY door is made of thin oak and has a peculiar resonant quality.

—W. T. MEENAN



General Electric

HOW "SOUND ATMOSPHERE" IS PRODUCED IN BROADCAST PLAYS

Here may be seen the door bell, telephone bell, clock chimes, bell buzzer and door-frame that constitute the noise "props" at station WGY.

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EGBERT, WHAT'S YOUR OPINION OF EDISON AND MARCONI?
EDISON AN' MARCONI? WHY, I THINK THEY BOTH SHOW CONSIDERABLE PROMISE, THEY'RE FAIRLY CAPABLE MEN
SAY OSWALD, I BOUGHT A NEW NEUTRODYNE SET. IT'S SO SHORT'S SIDEBURNS IN THIS OUTFIT TH' TRANSFORMER HAS NO IRON CORE A BIG ADVANTAGE
YEAH?
THIS TRANSFORMER IS TUNED TO ONE PARTICULAR WAVE LENGTH TO WHICH ALL INCOMING SIGNALS WILL BE METERODYNED IT'S INCORPORATED A RADIO-FREQUENCY TRANSFORMER RESPONDING TO SIGNALS OVER A WIDE BAND OF WAVE LENGTHS
M-M-SAY I'VE GOTTA BE—
JUSSA MINUTE! THIS IS AN AIRCORE TRANSFORMER, BUILT UP WITH VARIATIONS IN THE FUNDAMENTAL WAVE LENGTHS AND VARIATIONS IN THE MAGNETIC COUPLING.... THERE IS A GOOD METHOD OF COUPLING THE OUTPUT CIRCUITS AND THE OSCILLATOR TO THE RADIO-FREQUENCY AMPLIFIER.
NOW LEMME SHOW YOU THIS DIAGRAM. IT MAKES IT VERY SIMPLE. YOU WILL NOTICE IN THIS CIRCUIT—C1—ONE A FIXED CONDENSER .0005 MFD.; S1 AND J2—DOUBLE-CIRCUIT JACKS; J3—SINGLE-CIRCUIT JACK; R2 AND R3—FILAMENT RHEOSTATS, 20 OHMS; AF1 AND AF2—AUDIO-FREQUENCY AMPLIFYING TRANSFORMERS. NOW THEN—
ETC. ETC. FOR 10 BLOCKS
TH' FILAMENT RHEOSTAT SHOULD BE CONNECTED ON TH' NEGATIVE SIDE OF TH' BATTERY LEADS. YOU ASK EGBERT—HE'LL TELL YOU I'M RIGHT! LET HIM SETTLE THIS ARGUMENT
YOU'RE WRONG AN' I BET EGBERT WILL AGREE WITH ME!
GO GET EGBERT HE'LL KNOW
BILL'S RIGHT. WHY A CHILD OUGHTA KNOW WHERE TH' FILAMENT RHEOSTAT SHOULD BE CONNECTED
NOW D'YA BELIEVE ME?
IF EGBERT SAYS YOU'RE RIGHT THAT SETTLES IT!
I'VE ONLY SEEN YOUR CIRCUIT ONCE BUT I'LL MAKE A DIAGRAM OF IT—AT ANY RATE THIS IS THE WAY IT SHOULD BE
MARVELOUS! YOU'VE GOT EVERY DETAIL! IT'S UNCANNY!
EGBERT, I WANTT TO BUY A GOOD RADIO SET AND I WANT YOU TO TELL ME EXACTLY WHAT TO BUY
YOU'VE COME TO THE RIGHT PARTY
COPYRIGHT, 1924, THE NEW YORK WORLD, FROM PHOTOGRAPH BY COPYRIGHT
GOSH! HERE'S A HOT ONE THE EDITOR OF THIS RADIO MAGAZINE IS ALL WRONG FROM START TO FINISH IN THIS ARTICLE ON THE TRANSMITTER. I'LL WRITE HIM TONIGHT AN' SET HIM STRAIGHT
THAT YOU, EGBERT? THANK HEAVEN YOU'RE HERE! I WANT YOU TO PUT IN SOME NEW DRY CELLS FOR ME. THE FRONT DOOR BELL WON'T RING. I BOUGHT THE BATTERIES THIS AFTERNOON
3-10-24
EBSTER
SAY, WHAT D'YA THINK I AM? A MECHANICAL GENIUS OR SOMETHIN'?

Courtesy *The World*, New York

"POPULAR RADIO" LANDS IN THE COMIC STRIP

When Old H. T. Webster, one of the cleverest of our cartoonists, whose drawings are syndicated all over the United States, set out to take a good-natured fling at the radio fan, he naturally picked out the world's fastest-growing magazine for the inspiration for his technical dialogue. Readers of POPULAR RADIO *may recognize some of the "conversation" that was borrowed for the occasion from the pages of this magazine.*

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CONDUCTED BY LAURENCE M. COCKADAY

Does the Four-circuit Receiver Radiate?

QUESTION: In a recent issue of *Radio Broadcast* appeared an announcement of the "How far Have You Heard?" contest; one of the conditions of the contest was that the set should be of the non-radiating type. I inquired if my four-circuit set was eligible; the editor replied: "The standard four-circuit Cockaday set is an habitual offender as to radiating. We do not recommend its use." His comment is a direct contradiction to Mr. Cockaday's statement, and directly at variance with my own experience with it.

Please let me know if the four-circuit tuner radiates.

WALTER I. REDMOND

ANSWER: The four-circuit tuner does *not* radiate. This is because the coupling between the regenerative circuit and the antenna circuit is looser than in any other type of modern receiver.

An interesting test was recently made with a five-tube loop receiver; it was found that with the four-circuit tuner oscillating (a condition which is never used when receiving) signals could be picked up from it at a distance not greater than 20 feet away. This was the case whether the antenna and ground were connected to the tuner or not. This test proved that the antenna circuit was loosely coupled enough to prevent radiation, and that the signals picked up were from the secondary circuit coils themselves.

There are two families in New York City who use four-circuit tuners and both of their receivers are connected, in series, on the same antenna, as the landlord would not allow more than one antenna on the roof. Of course, the antenna circuit in this case is untuned, but they experience no trouble whatever from radiation.

Local Interference

QUESTION: I am located near a telephone exchange in my home town which uses a vibrator of some sort for "ringing." I have tried my antenna in all positions and still whenever I listen in I have to do so through an aural barrage of buzzes. My set (and a number of my friends are troubled in the same way) picks up the vibrations of the buzzer system, and reception is spoiled. Of course we have all got used to it and it doesn't bother us so much now, but when a new listener comes into my station, he notices it and wonders if all radio is like that.

This condition has kept a lot of really interested people from buying radio receiving apparatus in my town and I am wondering if you have ever heard of such a trouble and any means for eliminating it?

I will be glad to try anything, and the telephone company says they will cooperate with us if it doesn't interfere with their service. Do you know of anything that would cut down the radiation of the buzzer impulses *at the exchange?* We have tried everything at our receiving stations but it seems that the only way to do it would be to eliminate the signal at the exchange itself.

WILLIAM N. ANDREWS

ANSWER: The shunting of the ringer contacts with 2 to 4-microfarad condensers should cut down the sparking and the radiation enough to eliminate or, at least, reduce this interference to a point where it is no longer objectionable.

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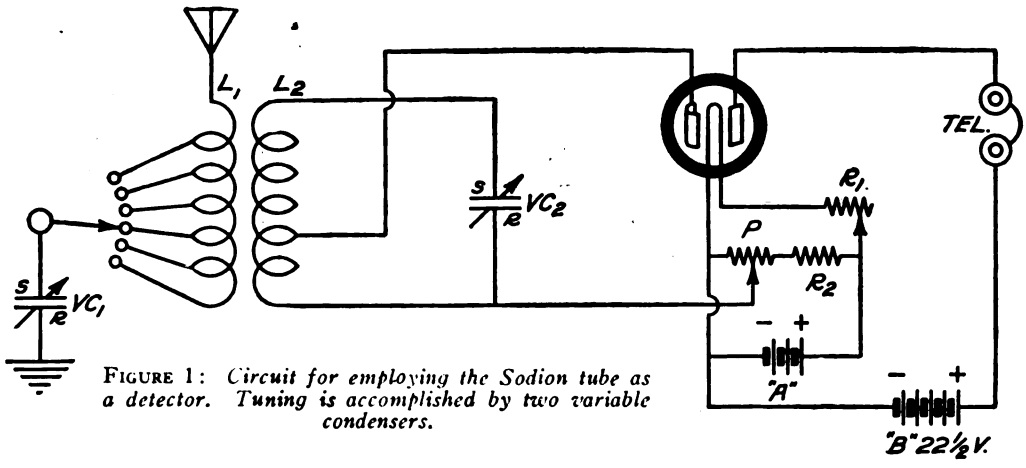

FIGURE 1: *Circuit for employing the Sodion tube as a detector. Tuning is accomplished by two variable condensers.*

Circuit for the Sodion Tube Detector

QUESTION: Please give me a diagram for the Sodion tube and the parts I will need for a single-tube set. I have the Connecticut 44-ohm potentiometer and the 100-ohm resistance to go in series with it, but I want to make the set myself.

Will you give me the necessary information?

S. B.

ANSWER: You will find the circuit diagram in Figure 1. The parts you will need are the following:

L1 and L2—primary and secondary windings for the fixed coupler;
VC1—variable condenser, .001 mfd.;
VC2—variable condenser, .0005 mfd.;
P—potentiometer, 44 ohms;
R1—filament rheostat, 20 ohms;
R2—fixed resistance, 100 ohms;
TEL—telephones.

The coupler may be made in the following way. Wind 42 turns of No. 18 DSC copper wire on one end of a composition tube, 6½ inches long and 3½ inches in diameter. Take off taps on this winding every 6 turns. Then prepare the secondary coil L2, starting ½ inch from the end of the first winding, with the same size of wire, and winding on 60 turns, with a tap at the 10th turn for the connection to the collector plate terminal of the sodion tube.

In tuning, the condenser VC1 and the taps on coil L1 control the antenna wavelength, while the condenser VC2 controls the secondary wavelength. The potentiometer P is used as a sensitivity or selectivity control, and will help in tuning in distance and in discriminating between stations operating on wavelengths not widely separated.

Regenerative Receivers on an Indoor Antenna

QUESTION: Is it possible to use an ordinary regenerative receiver on an indoor antenna strung around the picture molding?

If so, please tell me what kind of receiver will do and give the details for making such a set.

A. V. STUART

ANSWER: This is possible. Almost any good regenerative receiver can do this for local reception up to 500 miles or so.

There is an article in this issue which tells you just how to do the whole job of building and installing a set of this type.

Licenses for Receiving Equipment

QUESTION: Do I have to obtain a license to operate a receiving set in this country?

H. K.

ANSWER: No. No license is required in America. In some foreign countries, however, a license is issued and a tax is levied on all receiving apparatus.

Rheostat Resistances for Two Tubes

QUESTION: What resistance rheostat will I need for controlling two UV-201-a tubes in parallel?

I. STERN

ANSWER: Use a filament rheostat of 20 ohms resistance.

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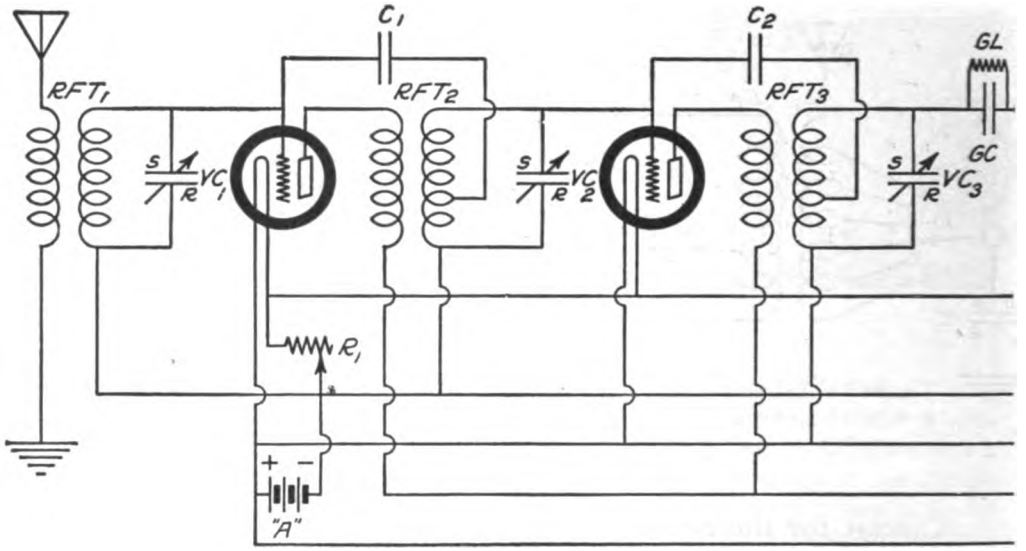

The Wiring Diagram for the Neutrodyne

QUESTION: Will you please give me the latest hook-up that you know of for the neutrodyne? Also I would like to get a list of the parts that will be necessary for constructing the set. I want to use two rheostats; one for controlling the amplifier tubes and a separate one for the detector tube. What size panel do I need?

ARTHUR BENTON

ANSWER: The diagram is shown in Figure 2. The parts you will require are the following:

RFT1—neutrodyne coupler;
RFT2 and RFT3—neutroformers;
VC1, VC2 and VC3—variable condensers, .00035 mfd;
R1 andd R2—filament rheostats, 6 ohms;
C1 and C2—Neutrodon condensers (compensating condensers);
GC—mica fixed condenser, .00025 mfd.;
GL—grid-leak, 2 megohms;
J1 and J2—telephone jacks, double-circuit;
J3—telephone jack, single-circuit;
C3—mica fixed condenser, .0005 mfd.;
AFT1 and AFT2—audio-frequency amplifying transformers.

The use of four hard tubes for the amplifiers, and one soft tube for the detector, is recommended. The set can be built into a 7 by 26-inch panel and cabinet.

What is an "L" Antenna?

QUESTION: What kind of an antenna is an L antenna? Is this a one-wire antenna? I was told I should put up an L antenna 100 feet long with a 30-foot lead-in, I think it was. What does all this mean? I have just bought a set but don't know how to put it up.

S. D.

ANSWER: An "L" antenna is one whose general form follows the shape of an inverted letter L. String a 100-foot length of wire between two horizontal supports and bring the near end down to your room. The wire should be insulated at both ends.

Coupling Between Two Receivers

QUESTION: While experimenting with a crystal set this evening, I discovered what seemed to me to be a very strange phenomena.

I had my antenna and ground fastened to a crystal set, consisting of a variometer, condenser and detector. I was listening with the phones to station KHJ, near-by, at Los Angeles.

Just below and about a foot in front of the crystal set was a four-circuit tuner, which I built from your specifications. This set had batteries and a loudspeaker attached to it but no antenna or ground connections.

While listening in on the crystal set, I was listlessly fooling with the rheostats on the four-circuit set, and lighted the tubes. Immediately the horn began to

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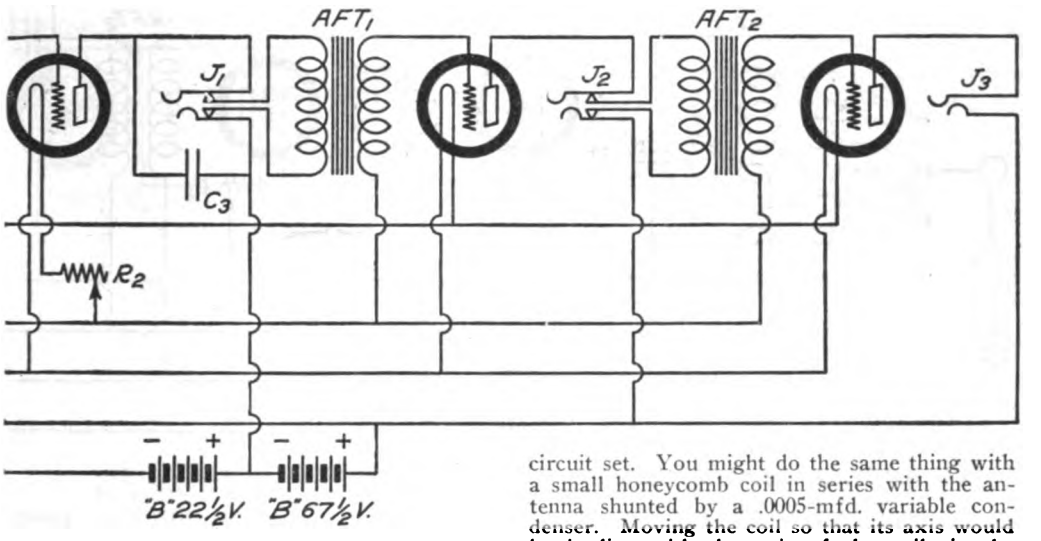
FIGURE 2: *The neutrodyne circuit employing two stages of tuned-radio-frequency, detector and two stages of audio-frequency amplification.*



function, in just as good shape as if the antenna and ground connections were attached to the four-circuit set.

Now, what I would like to know is, how the crystal set could radiate the energy across the foot or more of space between the two sets, with so much efficiency, if at all. I thought that crystal sets could not radiate.

Both the sets happened to be tuned to the same wavelength, for the same station. Can you throw any light on this experience?

A. E. WILKINSON

ANSWER: A crystal set does not radiate in the same sense that a regenerative, single-circuit receiver will do.

What you experienced was simply a case of extremely loose coupling (magnetic coupling) from the coils of the crystal set to the coils of the four-circuit tuner. This is due to the susceptibility of the four-circuit tuner to extremely loose coupling. The designer of this set has been able to use a coupling distance (between the antenna coil and the stabilizer and secondary coils) of as much as twelve feet and still get fine reception. This also increases the selectivity to such an extent that it may become too sharp in tuning.

You will notice, that if you lift the cat-whisker off the crystal, you will still be able to pick up the signals with the four-circuit set just as well.

This proves that you are using merely a tuned antenna circuit with loose magnetic coupling between it and the coils in the four-circuit set. You might do the same thing with a small honeycomb coil in series with the antenna shunted by a .0005-mfd. variable condenser. Moving the coil so that its axis would be in line with the axis of the coils in the four-circuit tuner will allow you to use a coupling distance as great as that across a whole medium-sized room.

Tubes Needed for DX Reception

QUESTION: How many tubes would it be necessary to use in order to get occasional reception on winter evenings over a distance of 3,000 miles, say, two or three nights a week.

J. F. D.

ANSWER: This depends upon local conditions, upon the ability of the operator to tune properly and upon the type of receiver used. We can only give you a general answer. There are several sets of various types that ought to be suitable for what you want, and these use from five to eight tubes each.

Distortionless Amplification

QUESTION: In your opinion, what is the form of audio-frequency amplification that distorts the least?

JAMES M. RIKER

ANSWER: The form of amplification that is least susceptible to distortion is one that is aperiodic as to frequencies lying within the audible range.

Such an amplifier is the type known as a resistance-coupled amplifier. Of course, this type of amplifier does not give the same amount of amplification per stage as the transformer-coupled type, but it is, or can be made, *free from all distortion.*

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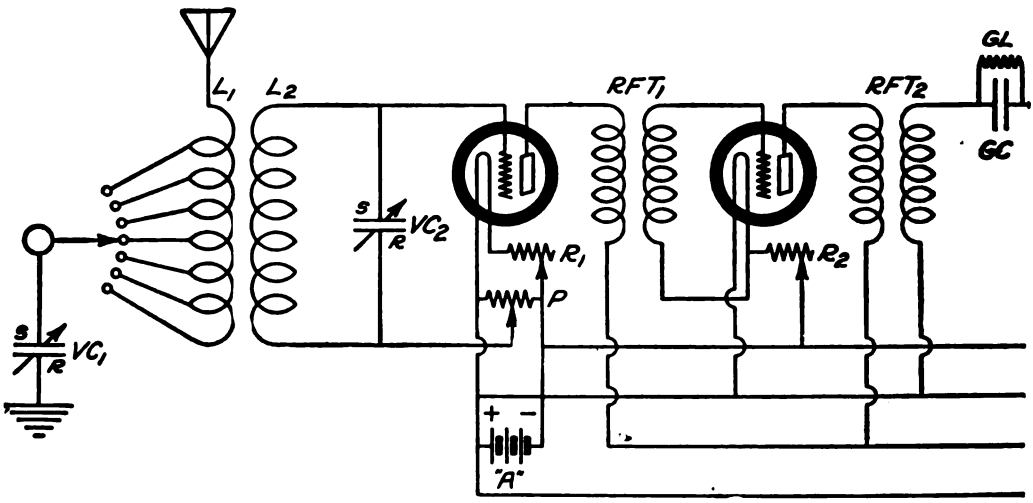

Transformer-coupled Radio Frequency

QUESTION: I have a Simplex variocoupler and two Cardwell condensers, that I have just taken out of an elaborate single-circuit set after reading of all the distortion and trouble I was causing in the ether around my house. I had one condenser in series with the antenna and the other across the stator coil.

I have taken the whole set apart, including the two-stage audio amplifier, and am going to change and build a transformer-coupled, radio-frequency set with five tubes. I don't want to make a tuned-radio-frequency set, as yet, because I am afraid it might be too hard for me to make and tune.

So, if you can give me the proper hook-up to use I will start in and build the set, leaving the more complicated set for the future when I may have gotten enough experience to build it. Please tell me the parts I will require for the complete five-tube set.

JACK WRIGHT

ANSWER: We have drawn the circuit you want in Figure 3. You should have no difficulty in making and operating a set of this type.

Below is a list of the instruments you will need to make the set:

L1 and L2—primary and secondary coils of a good variocoupler;
VC1—variable condenser, .001 mfd.;
VC2—variable condenser, .0005 mfd.;
RFT1 and RFT2—radio-frequency transformers;
C—mica fixed condenser, .0005 mfd.;
GC—mica fixed condenser, .00025 mfd.;
GL—grid-leak, 2 megohms;
J1 and J2—telephone jacks, double-circuit;
J3—telephone jack, single-circuit;
R1, R2, R4 and R5—filament rheostats, 20 ohms;
R3—filament rheostats, 6 ohms;
P—potentiometer, 400 ohms;
AFT1 and AFT2—audio-frequency amplifying transformers.

Of course, you will need suitable sockets for the tubes. The tubes recommended for the amplifiers are De Forest tubes or Cunningham C-301-a tubes or Radio Corporation UV-201-a tubes. The detector should be a soft tube such as a UV-200 or a C-300.

The potentiometer should give a nice control for regeneration in the first stage of radio, and the second stage is fixed by attaching the grid return from the transformer at such a potential that the second tube will regenerate somewhat, but will not oscillate. For sharp tuning, place the secondary coil L2 at as nearly right angles to the coil L1 as possible to receive signals of suitable strength. This loosens the coupling.

Avoiding Annoyance from Single-circuit Receivers

QUESTION: How can I learn to tune my single-circuit receiver properly so that I will not disturb my neighbors on the floor below? They tell me I interfere with them, and ask me why I don't learn to tune it right. I really would like to know, because I don't like to bother anybody, but I don't seem to be making any

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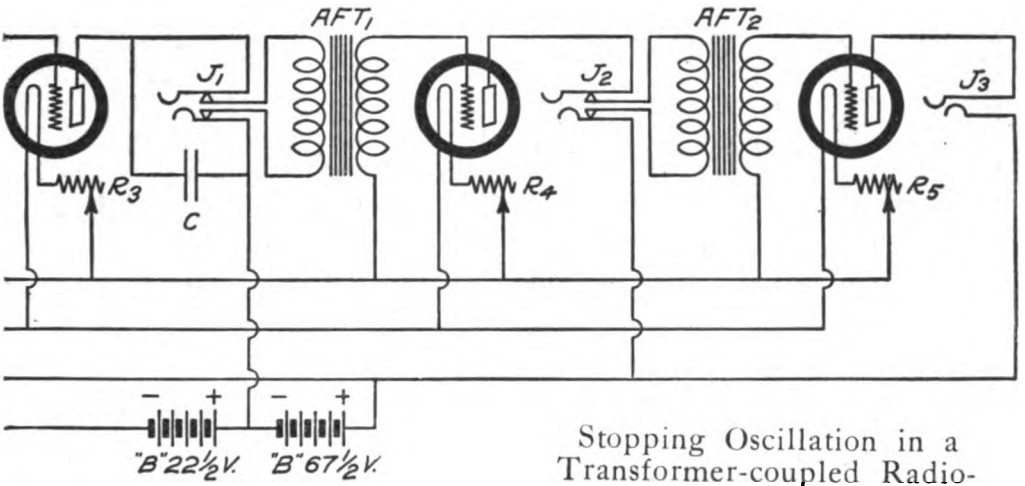
FIGURE 3: *Two stages of transformer-coupled, radio-frequency, detector and two stages of audio-frequency amplification.*



progress in learning by myself, and they came up last night during the President's speech and asked me to shut down. I did this and went downstairs with them and heard the speech perfectly. Have you ever published any information on this subject? R. B.

ANSWER: You will find the information you require in the article, "How NOT to Tune the Single-circuit Receiver," in the April, 1924, issue of POPULAR RADIO.

Where to Use Bare Bus-wire

QUESTION: Should bus-wire be covered with insulated tubing such as is popularly termed "spaghetti"?

WILLIAM AUSTIN

ANSWER: In wiring up circuits, such as the detector circuit, the wiring for a radio-frequency-amplifier, the antenna circuit, and, in fact, any circuit through which radio-frequency currents are flowing, the bus-wire should be used bare without any insulating covering. This is because the wiring can all be soldered rigidly in place. The dielectric, in this case, is air, which, as is well known, has a lower dielectric loss than any other material used as an insulator.

In audio-frequency circuits, such as the wiring of an audio-frequency-amplifier, the tubing can be used without appreciable losses. This is because the dielectric loss amounts to practically nothing at low frequencies.

In general, where any rigid type of wiring is used, it is better not to use insulated tubing except where two wires cross or run too close to each other for safety. Usually, however, the wiring can be arranged so that this does not happen.

Stopping Oscillation in a Transformer-coupled Radio-frequency Amplifier

QUESTION: I have built a five-tube set using two radio-frequency transformers of a well-known make and have trouble in eliminating oscillation in the radio-frequency amplifiers. I am using C-299 tubes throughout. Can you tell me how I can help this and control regeneration better than by filament control?

ED. BISHOP

ANSWER: A simple method would be to use a potentiometer connected across the "A" battery with the lever of the potentiometer connected to the grid return on the loop or secondary of the variocoupler in the first stage of radio-frequency amplification. Then by turning this you will be able to make the grid of the first tube either more positive or negative, with respect to the filament and thus control regeneration to a nicety.

Connect the grid return on the second stage between the rheostat and the filament of the second tube. This will eliminate oscillation in the second stage.

The filament rheostats of the radio-frequency amplifier should be connected in the negative side of the filaments.

Variable Grid-leak for Regenerative Detector

QUESTION: Will a variable grid-leak help any in place of a fixed 2-megohm grid-leak in my regenerative receiver?

DONALD SHARP

ANSWER: It will help considerably.

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ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

CONDUCTED BY DAVID LAY

Radio on Amundsen's Polar Trip

THE decision of the United States Navy not to send the great airship *Shenandoah* on her proposed flight to the North Pole this summer will not interfere, it is announced, with the plans of Captain Roald Amundsen for his exploration of the polar lands by airplane. The airplanes used will be equipped for landing on either ice or water and each will be provided with radio so that communication with the ship acting as base of supplies will be continuous. This ship, in turn, will be equipped with radio apparatus powerful enough to permit regular communication with civilization.

* * *

Philadelphia Police Automobiles to be Continual Listening Posts

IF you see a Philadelphia automobilist bearing down on you with earphones glued to his ears he is not a radio "nut," merely one of General Butler's new radio cops. All police autos are to be equipped with radio receivers and an occupant is to be required to listen all the time so that news of crimes or of sudden emergencies can be broadcast instantly to the force.

* * *

Feeling Radio with Sensitive Fingers

MISS HELEN KELLER, the famous woman who was born blind, deaf and dumb and who learned, nevertheless, to speak, and to talk and read with her fingers, has discovered that she can "hear" a radio concert by placing the tips of her fingers against the diaphragm of a headphone. The peculiar rhythms of different orchestral instruments and of the human voice were quite distinguishable, Miss Keller says, in this way. Furthermore, the meaning and thrill of the music was also communicable much as though it had been actually heard. Miss Keller is no doubt the possessor of the most highly trained and sensitive fingertips in the United States; her long experience in using them to read and talk with can have had no other result. Nevertheless, it may well be that her experience is not exceptional and that many persons who are totally deaf, even to the telephone or the radio, may be able to enjoy radio concerts in this way, by the "feel" of them on the vibrating diaphragm. There may be an opportunity here for the inventor. It ought not to be difficult to devise a diaphragm which would magnify this rhythmic feel of the voice or of music. Possibly even the ordinary tones of spoken words could be made perceptible and understandable in this way to persons who are incurably deaf.

* * *

Portable Sets Prohibited in Japan

THE government regulations for radio listeners in Japan, where broadcasting is just now beginning, are so severe that the development of a radio public is likely to be prevented altogether. For example, no one may possess a portable set of any kind, although sets may be fixed permanently to a specified boat or automobile.

* * *

How Many Radio Listeners Are There?

THE present radio audience is estimated by Mr. O. H. Caldwell of *Electrical Merchandising* (New York) as numbering over 8,000,000 persons. He predicts an audience of 15,000,000 by the end of 1924.

* * *

A Sea-going Fire Alarm by Radio

WHILE a ship was making her way out to sea recently from the harbor of New York City a ship's officer saw a fire on one of the docks along the shore. He spoke to the radio operator, the operator broadcast an alarm from his transmitter. This alarm was picked up by the radio receiver at Police Headquarters and relayed at once to the Fire Department, where it arrived in advance of the alarm from the signal box on the street.

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Radio a Boon for Crippled Workmen

"RADIO is opening up a new field of usefulness for those who are crippled from the waist down," states Miss Sylvia Harris, the head of the employment department of the Institute for Crippled and Disabled Men of New York, who has placed more than fifty crippled boys in radio assembly work. "It has been found," she states, "that crippled men are more satisfactory in this work than the average able-bodied man of the same mechanical ability."

* * *

Radio Time "Ticks" Save Much Worry for Ship Captains

IN the old days the captain of a ship had to have a timekeeper whom he could absolutely trust. The chronometer was the most important instrument aboard ship. Thousands of dollars were paid for especially good ones. If the captain was forced by any disaster to abandon his ship the chronometer went with him, carefully guarded by hand so that it would not suffer the faintest jar. An error of a few seconds in the chronometer might throw a captain entirely off his course and pile up his ship on the rocks. Nowadays this is unnecessary. A ship can be navigated, if need be, by an ordinary good watch costing perhaps ten or twelve dollars. The reason for the change is the prevalence of daily radio time signals. Such signals are sent out nowadays by scores of radio stations all over the world. Ships on every ocean can pick them up daily and correct the chronometer by which, together with observations of the stars or the sun, one's position at sea is determined. Probably no single service of radio to transportation has been as valuable as this one.

International

BROADCASTING A LOVER'S HEART PALPITATIONS

Dr. Phillips Thomas is the inventor of the ultra-audible microphone, the invention of which enables scientists to hear sounds that are otherwise inaudible. The noise that a fly makes while walking, the thunder of a moth's wings while in flight, the sounds of the honey bee, all are revealed with the aid of the Thomas microphone, which was first described in POPULAR RADIO *for April, 1923. Dr. Thomas is shown above, broadcasting from station KDKA the heart palpitations inspired by a lover's kiss. These palpitations, recorded in the ultra-audible microphone, were plainly heard by the crystal set receivers in England as re-transmitted from Manchester, England.*

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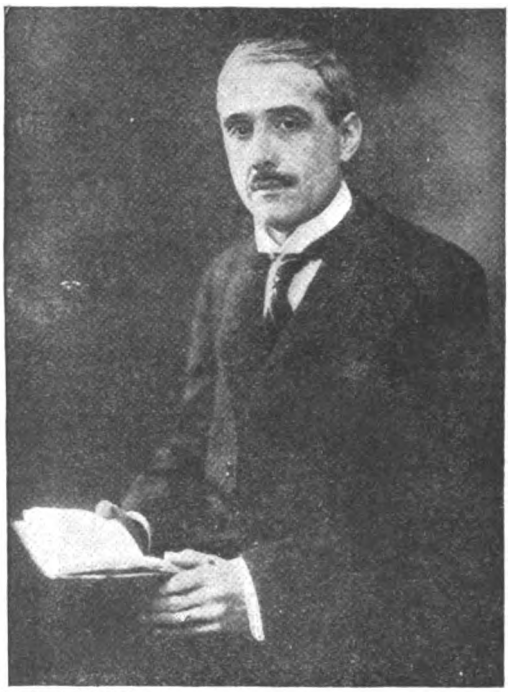
Amateur Receives Gold Medal for Transatlantic Feat

M. LEON DELOY, of Nice, France, the man who spanned the Atlantic on a 100-meter wave and who described this feat in the February (1924) issue of POPULAR RADIO, has received the gold medal of the Lakhovshy Foundation in recognition of this exploit and of its potential importance to the science of radio communication.

* * *

A New Record in Radio Relaying

ON March 7, 1924, six radio stations in New York City, Pittsburgh, Schenectady, Hastings, San Francisco and London (England) co-operated in broadcasting simultaneously the program of the Annual Alumni Dinner of the Massachusetts Institute of Technology, given in the ballroom of the Waldorf Astoria Hotel in New York. The program was first picked up and sent out by WJZ in New York City. From WJZ the material went by special land wire to WGY at Schenectady; here it was broadcast and was picked up by KDKA at Pittsburgh. KDKA retransmitted it on two wavelengths; the regular wavelength of 326 meters and also on the short wavelength of 94 meters now used by this station for relay work. This short wave was picked up by KFKX at Hastings, Nebraska, and relayed to KGO in Oakland, California. The same short wave reached the British stations through station 2AC at Manchester, which acted as the pick-up station for that side of the Atlantic. It is estimated that more than 50,000,000 people could have heard the program had they been listening.



Kadel & Herbert

EXPERT IN ATOMS BECOMES A FRENCH "IMMORTAL"

The Duke de Broglie, a nobleman who is world-famous among scientists for his studies of atoms, has been elected to the group of "immortals" in the French Academy of Sciences. It was the Duke de Broglie who invented the radio telephone used for submarine work during the war.

* * *

Radio Listeners Vote "Wet."

IN a radio voting contest held recently by Station WJAZ, Chicago, on the subject of national prohibition, over 47,000 votes were cast by telegraph at the voters' expense, the telegraph bill totalling over $30,000. The result was more than two to one in favor of modification of the Volstead act.

* * *

Radio Sleuths to Have Automobiles

IT is announced from Washington that the district radio inspectors are to be provided with automobiles, each equipped with portable direction-finding equipment. It will be easier, then, to track down illegal transmitting stations or points of troublesome interference from any source.

* * *

What is Your Score at "Radio Golf"?

THE new game of "radio golf" has taken hold of Washington. The object is to log as many DX stations as possible, and with as great a mileage as possible, during a specified period of time. Official "score cards" have been printed and circulated and an instrument called a "golfmeter" has been devised to show at a glance the mileage of a received station.

* * *

More Than 2,000,000 British Radio Fans

LATEST estimates of the number of radio listeners in Great Britain run from two million to three million. Less than a year ago the number was probably under 100,000. The great increase of interest is ascribed to the installation of a number of additional broadcasting stations, both for relay use and for independent broadcasting. A large part of the area of England can now hear one or more stations on a cheap crystal set.

* * *

What We Spend on Radio

ROGER W. BABSON, the economist, has told the *Crosley Radio Weekly* that he estimates the expenditures of the public on radio for 1924 as over $350,000,000. In Washington's time this would have been enough to run the whole country for years.

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INSPIRATION FROM THE ETHER

Mr. Ivan Andre, a distinguished European painter now visiting the United States, takes his radio set along whenever his work requires him to make sketches from nature. He uses two stages of radio-frequency amplification, detector and two stages of audio-frequency amplification, all arranged by reflex, so that three tubes do the work. The loop is in the lid of the case.

Balloon Antennas Proposed for Lifeboats

THE London periodical, *Engineering*, suggests that all lifeboats on ocean liners be equipped not only with small radio transmitters (as many now are) but with a small balloon ten or twelve feet long and capable of lifting the end of an antenna wire 200 or 300 feet into the air. This would permit radio communication over much greater distances in case of a disaster at sea. Gas for inflating this balloon would be stored, in compressed form, in a steel tank in each boat.

* * *

How to Test Your Wave Meter

THE standard frequency signals sent out by WWV, the radio station of the United States Bureau of Standards, are to be continued at intervals throughout the year. The frequencies transmitted will range between 166.5 kilocycles (about 1,800 meters) and 2,000 kilocycles (150 meters). Details concerning the dates of transmission, the frequencies to be used, the manner of transmitting the signals and the like may be secured by addressing the Bureau of Standards, Washington, D. C. But do not burden the Bureau with unnecessary correspondence; do not write unless you really have some reason to know.

The New Profession—Radio Entertainer

MAJOR GENERAL GEORGE O. SQUIER thinks that appearance before the microphone will soon be a separate profession, instead of a side line for actors, orators or musicians who earn their livings mainly in other pursuits. "The stars of the ear," says the general as quoted in the New York *Times*, "in 1935 will receive salaries comparable to those the stars in the movies—the stars of the eye—receive in 1924."

* * *

Amusing Theatre Crowds by Radio

IN London theatres the crowds seeking seats in the gallery are admitted nearly two hours before the commencement of the performance. One of the problems of the theatre management has been always to keep these patrons of the higher levels amused while they had to wait. If not amused to their satisfaction they were far too likely to amuse themselves by audible remarks concerning the personal peculiarities of the more aristocratic patrons who filtered in below as the evening went on. One London manager has solved this difficulty by radio; a loudspeaker installed in the gallery entertains the "gods" until it is time for the play to begin.

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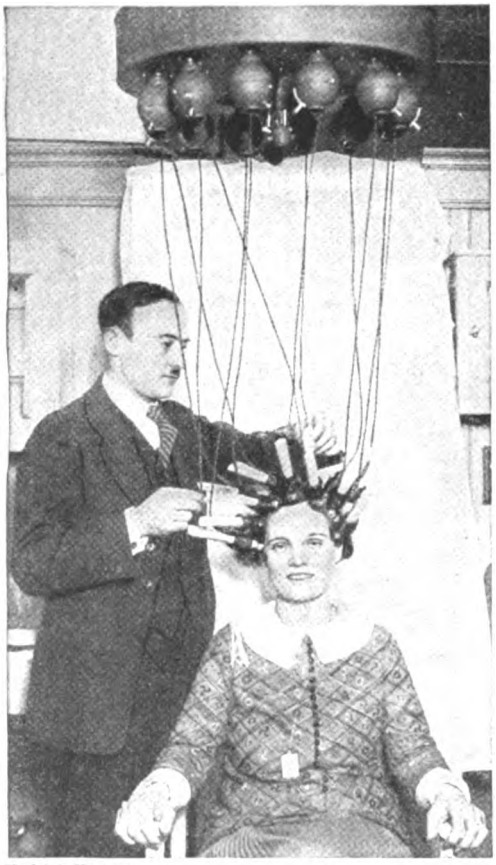
Another Project Spoiled by Radio

AFTER WGY had broadcast recently the "Get-rich-quick Wallingford" play that contains the famous incident of the carpet-covered tacks, the manager of the station was astonished to receive a visit from an excited lady who accused the station of having ruined her commercial prospects by broadcasting the secret invention upon which she had been engaged for months.

* * *

How Many Farmers Have Radio Sets?

A SURVEY by the Illinois Agricultural Association has showed that only about 10 percent of the farmers in 73 Illinois counties have installed radio sets. Considering the fact that every farmer ought to have a radio set, and doubtless would have one if he could afford it, this survey indicates that the "saturation point" of the radio market on the farms has not even been approached. Probably the trouble is that the farmers cannot pay for an expensive set and that the cheap sets which they can pay for will not bring in any stations if the farm is more than a few miles from town.



Kadel & Herbert

ETHER WAVES THAT MAKE THE HAIR WAVE

Ether waves—in the form of electromagnetic induction heat up the iron cores of the curlers and produce the desired "permanent wave" of the hair.

* * *

Sunday Listening a "Crime" in New Jersey

A FORGOTTEN "blue law," resurrected recently in New Jersey by advocates of a restricted Sunday, forbids nearly everything that modern people do on the first day of the week. Movies, music, street cars, gasoline filling stations, restaurants—all come under the ban. It is even illegal to listen to the radio, whether or not the music originates in another state. The fine, however, is only one dollar.

* * *

A New Station to Reach All England

A PROJECT is on foot in England to cover the whole country with a single broadcast from a new station to work on high power and on a wavelength of 1,600 meters. This will not replace the present short-wave stations but will supplement them. How long will it be before a similar project to reach all the United States with a single broadcast station will be proposed here? There would be many advantages in it if the wavelength used were high (or low) enough to prevent interference with the usual broadcasting range. For example, an address by the President could then be broadcast from the single station to the entire country.

* * *

Radio Audience Splits Evenly on Capital Punishment

ANOTHER instance of the efficiency of radio in obtaining an immediate reaction from the public on questions of the moment in public affairs was the vote of WEAF listeners on the recent debate between Warden L. E. Lawes of Sing Sing Prison and Senator William Love of New York State. The question was the retention or abolition of the death penalty for criminal acts; 48 percent of the voters favored capital punishment and 52 percent were opposed to it—a division so close that the vote must be considered essentially a tie.

* * *

A New Form of "Radio Heckler"

A "RADIO VANDAL" has made his appearance in Kansas City, according to the Democratic City Central Committee, which offered a reward of $500 for the arrest of the fan who interfered with the broadcasting of political speeches from Station WOQ during the heated city campaign. It was reported, that some one used an oscillator attached to an antenna for "hashing up" the politician's speech.

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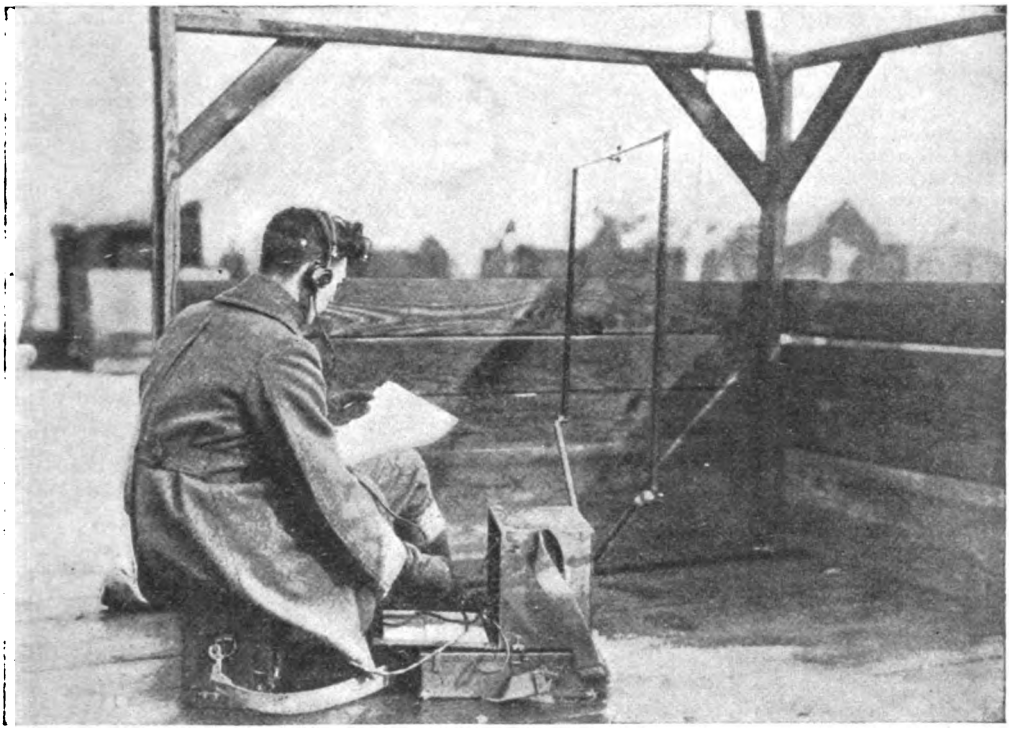

Kadel & Herbert

THE LATEST KIND OF PORTABLE LOOP

This new loop antenna was developed at the Camp Vail laboratories of the U. S. Signal Corps for use with the portable sets recently perfected by the army. The wires are inside a collapsible tube which can be folded up when not in use.

Thought Transference by Radio?

Two radio experiments have been conducted recently on the problem of thought transference. The speaker at the broadcasting station announces that he is concentrating his attention on a certain number or on a word or on some other single thing. All the listeners are asked to endeavor to receive, by thought waves, the unnamed idea which the announcer has in his mind. Of course this is not a *radio* experiment, it is merely the familiar telepathy experiment in a new setting. All that the radio does is to serve as a means of reaching more hearers and hearers who are located over a wider area.

* * *

Radio Detector from a Lump of Coal

An unnamed navy officer quoted by Carl H. Butman has described some experiences with detectors back in 1906 when tubes were unknown and when the movable catwhisker was one's only resource. To avoid the dislocation of the catwhisker by the jars of gun fire this officer took a lump of coal and drove into it an ordinary steel needle. It worked—perhaps the first fixed crystal detector ever constructed. Signals were faint but readable. With what we know about the accessories of crystal reception perhaps the lump-of-coal detector might be worth trying again.

* * *

What is "Television"?

Mr. C. Francis Jenkins, familiar to readers of Popular Radio as the inventor of the famous "radio movies," complains about the loose use that is coming to be made of the word television. It has been used, he remarks, for all forms of transfer of sight-images to a distance whereas it ought to be applied (as is the word "telephone") only to such transfers as take place by wire. For the transmission of pictures or sights by radio Mr. Jenkins suggests the new word "radiovision," analogous to "radiophone."

* * *

Two-Way Amateur Communication with Australia

American amateurs, as well as American broadcasting stations, were first heard in Australia some time ago. Now an Australian amateur, Mr. E. H. Cox, 3BD, of Elsternwick, has been heard by a Japanese amateur resident in the United States, Mr. Y. Ito of 6ACW. The editor of the *Radio Journal* (Los Angeles) has confirmed the claim.

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Wanted—a List of Radio Clubs

So many inquiries are being made for a list of radio clubs that the National Radio Chamber of Commerce has decided to compile one. The secretaries of all such institutions, here and abroad, who desire to be included are invited to communicate with Tresham D. Gregg, Secretary of the National Radio Chamber of Commerce, 165 Broadway, New York City. The following facts are desired:

the name of the club or associatoin;
its general purposes;
the number of its present members;
the date and place of next annual meeting;
the name and address of secretary.

* * *

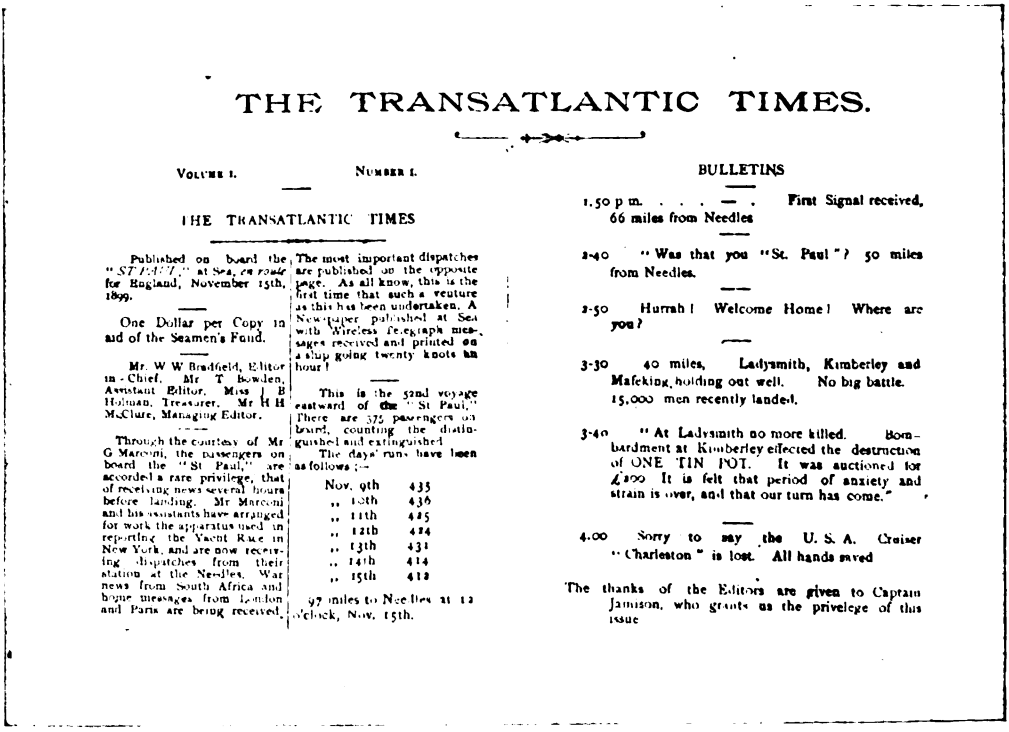
"Libel by Radio"

For the first time in history police have been asked to probe an alleged "libel by radio." The unique incident occurred "somewhere in Texas" recently when a police bulletin was broadcast about a well-known Texan who was sought by the Dallas police. The radio broadcaster had no reason to doubt the authenticity of the bulletin, and broadcast the name of the well-known Texan. Dallas police reported later that the father was listening in when the description was broadcast; he instantly went to police headquarters and demanded an explanation. He was informed that his son was not sought and was not suspected of an offense. Detectives now are attempting to discover the author of the description. The local broadcaster is unable to explain how the description happened to be included among the numerous notes given him by the police. The police suspect that the libel was broadcast by a secret sending station that received good pay for broadcasting the scandal.

* * *

Radio and the Country Church

The circuit rider, once so familiar a figure in rural America, seems to have become less common with the years. Many rural churches, we are told, have been closed or are used only seldom because of the difficulty of securing preachers. Radio promises to solve this difficulty, as it has solved so many other problems of isolated communities. Receivers are being installed in such churches so that sermons from the city pulpits, addresses from presiding bishops and similar material can be made available to the most inaccessible community. It is reported, also, that a broadcasting station is to be installed at the Vatican and that the spoken words of the Pope are to be sent, by relay broadcasting, to all the Catholic churches in the world.



THE TRANSATLANTIC TIMES.

VOLUME I. NUMBER 1.

THE TRANSATLANTIC TIMES

Published on board the "*ST. PAUL*" at Sea, *en route* for England, November 15th, 1899.

One Dollar per Copy in aid of the Seamen's Fund.

Mr. W W Bradfield, Editor in-Chief. Mr T Bowden, Assistant Editor. Miss I B Holman, Treasurer. Mr H H McClure, Managing Editor.

Through the courtesy of Mr G Marconi, the passengers on board the "St Paul," are accorded a rare privilege, that of receiving news several hours before landing. Mr Marconi and his assistants have arranged for work the apparatus used in reporting the Yacht Race in New York, and are now receiving dispatches from their station at the Needles. War news from South Africa and home messages from London and Paris are being received.

The most important dispatches are published on the opposite page. As all know, this is the first time that such a venture as this has been undertaken. A Newspaper published at Sea with Wireless Telegraph messages received and printed on a ship going twenty knots an hour!

This is the 52nd voyage eastward of the "St Paul." There are 375 passengers on board, counting the distinguished and extinguished.

The days' runs have been as follows:—

Nov. 9th	435
,, 10th	436
,, 11th	425
,, 12th	424
,, 13th	432
,, 14th	414
,, 15th	418

97 miles to Needles at 12 o'clock, Nov. 15th.

BULLETINS

1.50 p m. . . . . — . First Signal received, 66 miles from Needles

2-40 "Was that you "St. Paul"? 50 miles from Needles.

2-50 Hurrah! Welcome Home! Where are you?

3-30 40 miles, Ladysmith, Kimberley and Mafeking holding out well. No big battle. 15,000 men recently landed.

3-40 "At Ladysmith no more killed. Bombardment at Kimberley effected the destruction of ONE TIN POT. It was auctioned for £200 It is felt that period of anxiety and strain is over, and that our turn has come."

4.00 Sorry to say the U. S. A. Cruiser "Charleston" is lost. All hands saved

The thanks of the Editors are given to Captain Jamison, who grants us the privelege of this issue

THE "FIRST RADIO NEWSPAPER"

Unless evidence is furnished to the contrary, this little news sheet, published as far back as November 15, 1899, holds a unique record in the journalistic world. It was printed on the steamship ST. PAUL, *and contains the first printed news items ever received by "wireless."*

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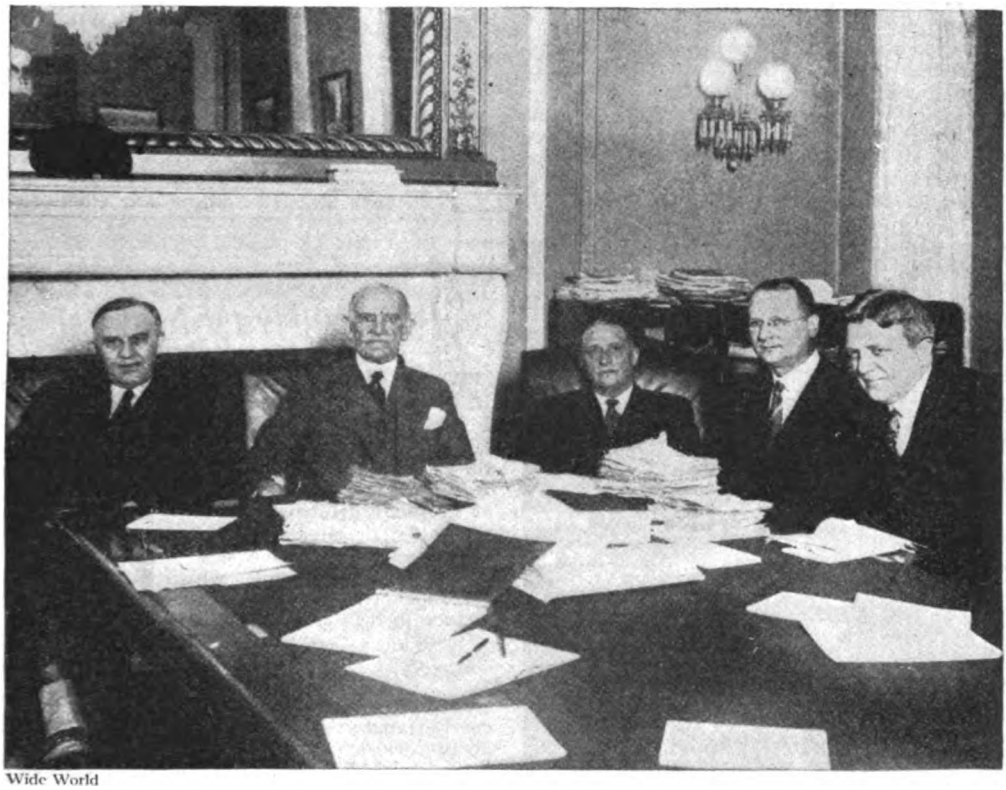

Wide World

WHERE THE FIGHT FOR "THE FREEDOM OF THE ETHER" BEGAN

Before this Senate Patents Committee (left to right, Senators Brandegee, Ernst, Robinson, Brussard and Dill) the first hearings were held on the Dill Bill to amend the copyright laws that would permit the free use of copyrighted music by radio broadcasting stations.

530 *Broadcasting Stations*

THERE are now about 530 licensed broadcasting stations in the United States. Of this number, 14 are operated by manufacturers of radio apparatus, 27 by religious organizations and about 100 by educational institutions.

* * *

Reaches 99 Percent of the World's Inhabitants

ACCORDING to E. F. McDonald, president of the National Broadcasting Association, 170,000 replies to a voting contest were received by one station in Chicago. Advertising experts estimate the ratio of replies to those reached was one in fifty, thus giving the single station a theoretical audience of 8,000,000. The Chicago stations reach 99 percent of the world's population, he added, Java alone being out of the zone of receiving, as indicated by correspondence.

* * *

Are You a "Middlebrow"?

THE radio audience is commonly divided into the "high brows" who like grand opera and symphony concerts and the "low brows," who don't. But a correspondent writes to *Popular Wireless* (London) protesting against this classification. More than half of the people, he thinks, are really neither high of brow or low; they are what he christens "middlebrows." They like something from all classes of music; a little jazz, a little classical music, a little dance music, once in a while an old-fashioned song. Too much of any one thing is—too much.

* * *

Special Dramas for the "Talking Movies"?

DR. LEE DE FOREST, himself the inventor of one kind of talking motion picture, the phonofilm, believes that we will need special radio dramas. The motion picture drama, he points out, is never a mere photographic reproduction of a stage play. The screen has its own criteria, quite different from those of the spoken drama. The plays themselves must be an entirely different kind of dramatic production. The talking movies will develop, Dr. De Forest believes, still another new form of dramatic writing and a new technique.

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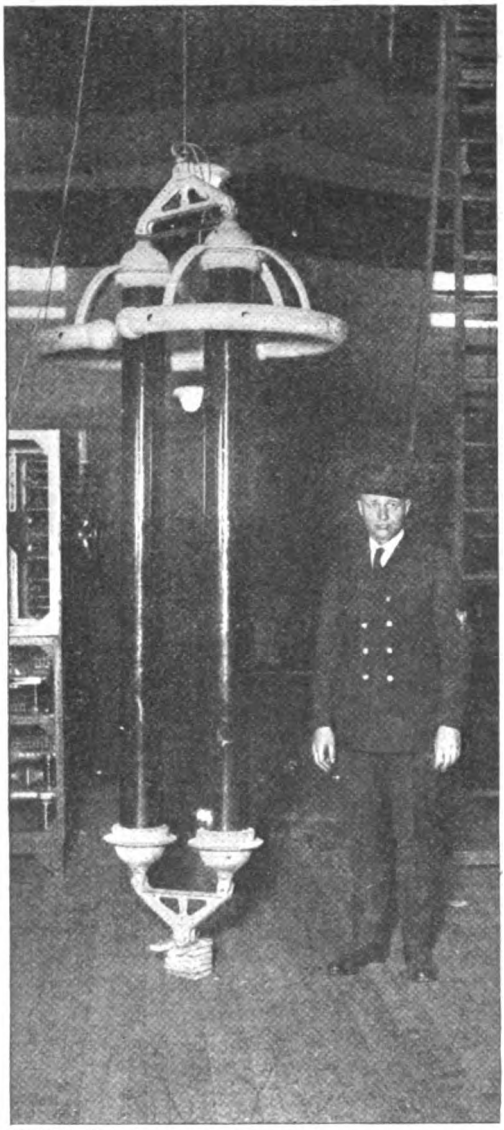
Radio Invades Land of Romance

ROMANCE gathers about names. Zanzibar, Singapore, the Seven Cities of Cibola—such names sound alluring, whatever the places may be like. Another is the Vale of Kashmir. And now this last one yields to radio. Communication being difficult in that country, a radio service is in operation between the cities of Jammu and Srinagar.



Kadel & Herbert

THIS INSULATOR WILL STAND A STRAIN OF 52,000 POUNDS

This remarkable high-power arc tower insulator is used at the 500-watt radio station at Annapolis, Maryland; beside it stands Chief Electrician A. H. Johnson, U. S. N.

Love Finds a Way—By Radio

ACCORDING to a dispatch from Nova Zembla two of the residents of that isolated Arctic island decided recently to get married. But there was no official on the island who had legal authority to marry them. What to do? Someone thought of the radio station. Thence all parties repaired, the Russian commissioner at Archangel was secured on the ether, the necessary questions and responses were passed over the radio waves, and the certificate was transmitted to the happy couple in the same way.

* * *

Broadcasting the Sound of Heart Beats

WHEN the radio stethoscope of Professor R. B. Abbott (described in POPULAR RADIO for February, 1924, page 204), was tried recently from Station KSD of St. Louis, the sound of the beating heart was heard in Canada, in San Antonio, Texas, on the Atlantic Coast, and at Fresno, California, thus covering almost 100 percent of the area of the United States. This heart beat could have been heard by more than 100,000,000 people, which is probably a record for the number of persons that had a chance to hear a single heart.

* * *

Some Statistics on Radio

MAJOR GENERAL JAMES G. HARBORD has recently stated that there are in the United States about 3,000,000 radio receiving sets; 10,000,000 listeners; 543 licensed broadcasting stations; 250,000 persons directly and indirectly connected with the industry; 3,000 manufacturers of radio apparatus; 1,000 wholesale dealers in radio sets; 20,000 retailers of all kinds who handle radio equipment; 1,000 newspapers carrying radio programs and radio news departments; 2,500 country weeklies which feature radios; 50 exclusively radio periodicals; 50 magazines with radio sections; 250 popular and technical books written on radio, and 7 trade papers devoted exclusively to radio.

* * *

A Radio-equipped Fire Patrol

THE roadster used by the superintendent of police and fire signals of Dallas, Texas, is equipped with a radio apparatus in order that the driver may pick up fire alarms while driving about the city streets. Under this system it is possible for the superintendent of signals to keep in touch with the central fire station, although he might be several miles away in a distant section of the city. An incident which proved the value of the innovation developed recently when Superintendent Garrett was speeding across a concrete viaduct on his way to a fire in the western outskirts of the city; an alarm was turned in from the extreme eastern edge of the city eleven miles distant. Superintendent Garret quickly visited the first fire and informed his chief that a blaze had developed in another section, thereby permitting him to properly divide various fire fighting companies.

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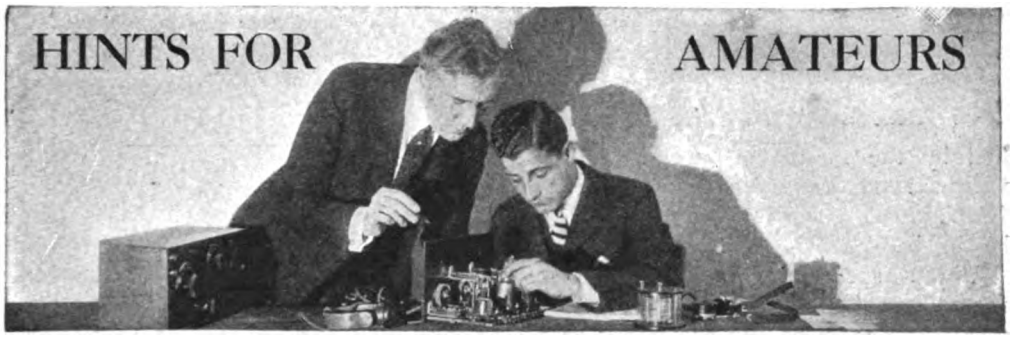

CONDUCTED BY ALBERT G. CRAIG

Mounting Inductive Instruments in a Radio-frequency Circuit

IN making up the design for a set, place the inductive instruments, such as variometers, variocouplers, coils, and radio-frequency transformers, in such positions that they are not near either the surfaces of the wooden sides of the cabinet or the panel material. Also be sure that the metal parts of condensers or audio-frequency transformers are not placed within the fields of these radio-frequency instruments.

If you take these precautions, you will find that you will get much better results on account of the elimination of any possibility of hysteresis or eddy-current losses.

Adapters for Dry-cell Tubes

IF you have a set that uses the larger type of tubes, of course, the easiest way to convert it into a dry-cell set is to use adapters.

If, however, you intend to build a set for the dry-cell tubes, it would be advisable to use smaller sockets that will fit the dry-cell tubes *without* adapters.

If you *do* use adapters in a set be sure that they are made of good insulating material. Also be sure that they *fit* the sockets you are using. Be sure that the dry-cell tubes fit *them;* otherwise, you will experience trouble from poor contact in either the filament circuit or the grid circuit.

Adapters work perfectly satisfactorily in audio-frequency work, but the added capacity introduced between the tube elements is a detriment to radio-frequency work. This added capacity is due to the extra capacity between the metal contact pieces in the adapter itself.

Make Neat Soldering Jobs

BEFORE you try to wire up your first set, it would be advisable to practice soldering some spare wires together so that you learn to do a neat job and thus avoid spoiling the instruments you have procured for the set.

Use soldering paste or flux sparingly and do not allow it to run onto the windings of instruments or onto the insulation.

Use only enough solder to make a fast joint.

Use an electric soldering iron.

Short Connections

IN laying out a receiver, place and turn the instruments so that the connecting wires may be as short as possible. At the same time, do not overcrowd the instruments.

Put a Pan Under Your Storage Batteries

DON'T let the acid spill from the storage battery onto the carpets. It will eat a hole. Keep the battery on a rubber pan or mat. These can be obtained in radio supply stores.

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Ratios for Audio-frequency Transformers

So many amateur builders are mystified by the numerous specifications of various ratios for audio-frequency transformers that a word about their use will be timely.

These specifications include ratios from 3 to 1 to 10 to 1. By ratio is meant the ratio of the secondary turns of wire to the primary turns.

High-ratio transformers are used, often, in single-tube reflex sets, with a crystal detector, and in some cases where only one stage of audio-frequency amplification is used. However, a high-ratio transformer, if it is not carefully designed, will produce distortion.

Lower ratio transformers are used advantageously in the second or third stages of audio-frequency amplifiers.

For best results transformers of 5 to 1 ratio are recommended in the first stage and not more than 3½ to 1 for the second or third stages.

When Should "Spaghetti" Be Used?

"SPAGHETTI," or varnished-cambric tubing, should be used wherever two wires must be brought close together, or cross each other and where there would be a chance of a short circuit. Its use, however, should be discouraged wherever possible for radio-frequency circuits, such as in a radio-frequency amplifier or in a detector circuit. In audio-frequency circuits, especially on the high-voltage plate leads, it is advisable to prevent wires touching and spoiling the batteries. It can be used on the filament connections.

Metal Shields on Panels

DON'T use extensive metal shields on the back of panels. If you do, you may lose some efficiency on account of intercapacity between instruments. If you must shield an instrument use a small one that shields the instrument in particular, without forming a capacity (to other instruments) which might be harmful.

When to Use "C" Batteries

WITH ordinary six-volt tubes, used as amplifiers, the correct, free grid potential may be maintained by connecting the filament rheostats in the negative lead from the filament to the "A" battery, and by connecting the grid return from the transformers to the negative "A" battery terminal. This will suffice for all plate potentials up to ninety volts. If more than this plate potential is used a "C" battery should be used. The amount used should be determined by trying out "C" battery voltages from 1½ volts up to 9 volts, according to the amount of plate voltage applied to the tube.

Small dry-cell tubes, used as amplifiers, should have "C" batteries connected in their grid circuits when more than 45 volts plate potential is applied.

To determine the correct amount, obtain two 4.5-volt "C" battery units and connect them in series, in the grid circuit, between the transformers and the negative filament. Then try the various taps on the batteries until the best results are obtained.

The "C" battery should always be connected with its negative terminal toward the grid.

Keep Radio Receivers Dry

DON'T leave the window open above your radio set. If it happens to rain, water may get in on the coils or transformer and cause trouble due to short circuits.

Radiation from Direct-coupled Regenerative Receivers

Do not allow your set to whistle while tuning it for distant stations. This will produce oscillations in the antenna circuit which will radiate and cause interference for your neighbors.

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CONDUCTED BY DR. E. E. FREE

How Electrons Move Through Wires

WHEN an electric current flows through a copper wire what happens, really, is that a stream of electrons is passing through it. The copper itself is made up of atoms, billions on billions of them arranged in a more or less fixed pattern or framework, like a lot of billiard balls strung on criss-crossed wires.* These copper atoms themselves contain electrons but it is not these atomic electrons that carry the electric current. The current-producing electrons are *loose* ones; they drift around in the empty space between the atoms of copper. When more of these loose electrons drift toward one end of the wire than toward the other end we say that a current is flowing.

This point of view is the one now held by the majority of scientists but there is still much uncertainty about the details. It is probable, for example, that the thing which we call electric "resistance" is due, really, to the opposition offered by the atoms and by their permanently bound electrons to the passage through them of the loose electrons that drift around at will and that make electric currents. But just *how* is this opposition manifested? Is it a mere jostling of the loose electrons against the more massive atoms? Or is it an electric attraction between the electrons and the atoms? Or is it (as seems, indeed, to be the most probable) an actual exchange of position from time to time between the free electrons and the atomically bound ones?

This last idea would be a good deal like the children's game in which most of the children form a ring with one extra child inside (or outside) of it. This extra child tries, according to some ritual prescribed by the rules, to break into the ring. If he does so another child is forced out.

This, it seems, may be what happens among the atoms. An atom of copper, for example, has 29 electrons belonging to its "ring." Suppose a new, loose electron drifts up from outside. It may be, the scientists think, that this new electron will displace one of the 29 bound electrons in the copper atom and will take its place. Then the ousted electron drifts on in its turn as a "loose" one. The mechanism of electric conduction in wires would be determined, therefore, not only by the jostling of the loose electrons against the relatively unmoving atoms, but also by the rules that control the electronic "game"; that control, that is, the displacement of a fixed, atomic electron by an arriving loose one.

But all these ideas are really little more than guesses. The plain fact of the matter is that we do not know how the electrons move through wires. The movement of a direct current of electricity in a wire is still a mystery that all our theories leave unexplained.

Therein lies the importance of a comprehensive investigation that has been begun in the physical laboratories of Cornell University. It is planned to take the one electrical phenomenon of resistance and to study this very accurately for pure substances and over a wide range of temperatures. The first installment of this work has been done on the so-called alkali metals; sodium, potassium, lithium, caesium and rubidium. The results have just appeared from the pen of Dr. Charles C. Bidwell.*

While this study will have its main value in that it supplies, for the first time, complete and accurate information as a basis for theorizing, it possesses, also, one feature of immediate interest. It shows how the melting of the metal affects the resistance to the passage of electrons.

Dr. Bidwell finds that the electrical resistance of these metals *increases* just before they

* This idea of the structure of metals like copper was explained in detail in the article entitled "700,000,000,000,000,000,000,000 Electrons for a Cent" in POPULAR RADIO for January, 1924, page 41. The modern theories concerning the fixed electrons, the ones that are bound inside the structure of the atoms themselves, were explained in the article entitled "Bohr's New Theory of Atoms" in POPULAR RADIO for April, 1924, page 319.

* "Electrical Resistance and Thermoelectric Power of the Alkali Metals," by Charles C. Bidwell. *Physical Review* (Corning, New York), vol. 23, pages 357-375 (March, 1924).

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begin to melt. This happens while the metal still seems to be solid. But evidently the atoms in it have begun to shift around a little. They are commencing to leave the fixed positions that they occupy in the rigid solid. And they begin, then, to offer more resistance to the loose electrons that are moving through them. This circumstance, and especially the numerical details that Dr. Bidwell offers concerning the temperature at which it occurs, ought to prove of value to the theorists who are endeavoring to unravel the secrets of the motion of electrons in wires.

Incidentally, some recent experiments of Dr. A. T. Waterman of Yale, have led to an estimate, believed to be fairly accurate, of the number of these loose electrons that exist inside metallic wires.* This number turns out to be about 100,000,000,000,000,000 electrons in each cubic centimeter of metal at the temperature of melting ice. There would be about 50,000,000,000,000 such free electrons in a piece of copper wire the size of an ordinary pin head.

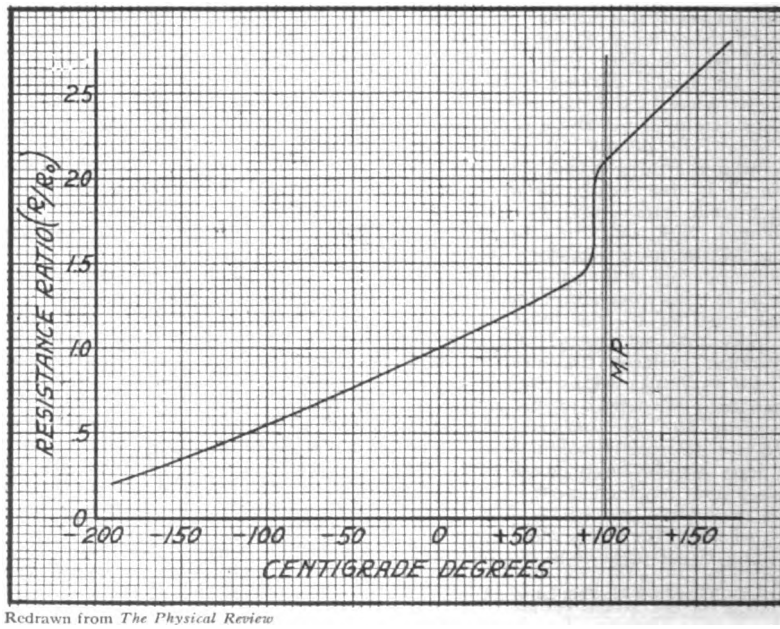
Large as this is, it is only a minute fraction of the total number of electrons in the wire. There are, in fact, some twenty million fixed electrons for each one of the loose electrons. If you imagine all the people in the two states of New York and Pennsylvania standing each in a certain fixed place and one lone man wandering around among them as the only movable individual, you will have a pretty fair picture of what existence must be like for each loose electron in a copper wire.

* "The Variation of Thermionic Emission with Temperature and the Concentration of the Free Electrons Within Conductors," a paper read before the meeting of the American Physical Society, Cincinnati, December, 1923; published in abstract in the *Physical Review* (Corning, New York), vol. 23, page 299 (January, 1924).

Radio is Being Tested for Mine Rescues

EVERY few weeks the newspapers carry huge headlines announcing that somewhere a mine has caved or exploded and that dozens or hundreds of unfortunate miners are entombed, no one knows whether alive or dead. The efforts of the United States Bureau of Mines have gone a long way to decrease the toll of human lives that these mine disasters demand, but one problem of mine rescue work has not yet been adequately solved. This is the problem of communicating with the buried men after a disaster has occurred.

It commonly happens that the explosion or fire or whatever caused the disaster destroys the usual means of communication, such as bell-wires or wire telephones. The rescuers who enter from the surface seldom know where the entombed men are or whether they have sufficient air or even how many of them are still alive. There is great need, therefore,



Redrawn from *The Physical Review*

WHAT HAPPENS TO THE ELECTRONS WHEN A METAL MELTS

This curve shows how the resistance of a piece of metallic sodium changes as the temperature rises from nearly 200 degrees below zero to well above the temperature of boiling water. The line marked "M.P." indicates the melting point. Note that the resistance increases sharply just before this line is reached, indicating the softening of the atomic structure inside the metal.

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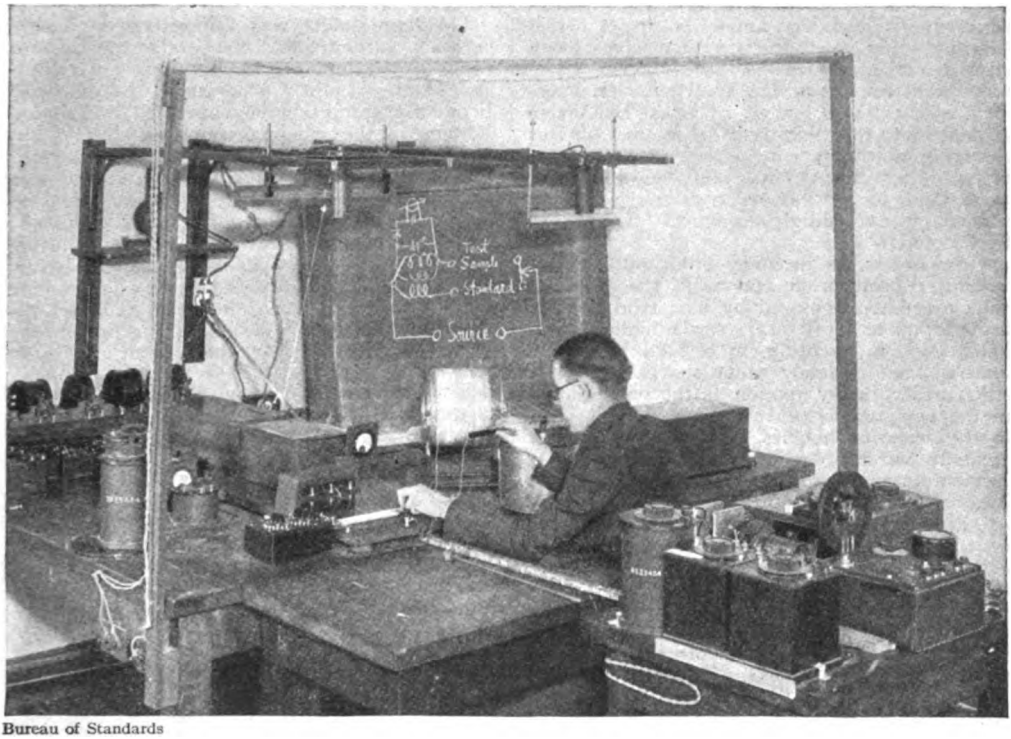

Bureau of Standards

MEASURING EFFECTIVE CAPACITY, INDUCTANCE AND RESISTANCE

The arrangement and behavior of the electrons inside the metal of the wires determine the properties of electric circuits. This shows the balanced transformer set used at the Bureau of Standards for the rapid measurement of radio capacity, inductance and resistance.

for some emergency method of communication that will not be put out of commission by any ordinary accident.

The officials of the Bureau of Mines, suspecting that some application of radio might furnish an answer to this problem, are making a study of the possibilities of radio for mine use. The first report issued is by Mr. J. J. Jakosky of the Pittsburgh Station of the Bureau and deals with the possibility of using the well-known ground-telegraph or "T. P. S." system developed by the Signal Corps of the United States Army.*

The conclusion reached by Mr. Jakosky is that the T. P. S. system can be used underground and may prove to be of value in some instances. There are, however, some serious difficulties arising from the fact that this system is subject to much interference from accidental sources or ground currents, such, for example, as leakage currents from electric railways or from power lines.

More important still, this system requires the use of telegraphic code and it cannot be expected that among every group of entombed miners there will be an individual who understands the code. The final radio system for underground rescue work will probably have to be a system permitting the use of the voice and not requiring an expert operator at either end. This conclusion Mr. Jakosky points out. The search for such a system will be continued by the Bureau.

* "Underground Signalling for Mines by the Ground-conduction or 'T. P. S.' Method," by J. J. Jakosky. United States Bureau of Mines (Washington, D. C.). Reports of Investigations (mimeographed), no. 2576, 11 pages, issued February, 1924. The T. P. S. system of signalling as employed on the surface of the ground by the Signal Corps was described in POPULAR RADIO for May, 1924, page 490.

Should the Amateurs be Permitted to Use Short Waves?

THIS question is raised editorially in a recent issue of *QST*, the official organ of the American Amateur Relay League.* At present the amateurs are restricted to the band between 150 and 200 meters, except for those few individuals who are fortunate enough to possess a special experimental license.

There are many reasons for believing that a limited permission to the amateurs to use waves between 150 and 50 meters would result in important scientific advances, as has been the

* "The Short Waves," editorial, *QST* (Hartford, Connecticut), vol. 7, no. 8, page 7 (March, 1924).

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case, indeed, whenever the thousands of experimentally inclined amateurs in America have been permitted to turn themselves loose on any subject.

A recent remark of Dr. W. H. Eccles, President of the Radio Society of Great Britain, in an address to that Society, is of interest. After referring to the recent successes of amateurs in spanning the Atlantic on the 100-meter wave and to the prospective use of these waves in exceedingly practical ways, Dr. Eccles said:*

"In wireless, as in many other pursuits requiring concentration and skill, the best results are often achieved by men who are not brought up to work at it for a living. This holds good in yachting, in cricket, in marksmanship and in many other sports. It holds still further, in my opinion, in the sciences and in the applications of science; and, especially, in the scientific hobbies, including, of course, amateur wireless, which, in addition to its fascination as a sport, possesses, also, the qualities of immediate importance in commerce and of utility in national emergency. It is quite conceivable that these discoveries of the properties of short waves may be of great commercial service, and certainly might be of immense military significance in time of war."

The greatest untouched field of radio today is the field of short waves; not only the waves down to 50 meters but those even below this limit. The greatest agency for radio investigation in the world is the existing body of American amateurs. We think, with *QST*, that it is worth while to bring this opportunity and these men together. What is the Government going to do about it?

How Fast Are Radio Waves?

THE books say that radio waves move with the speed of light, 186,329 miles a second. It must be admitted, however, that this is really an inference rather than a proven fact.

We know that radio waves are much like light (probably *exactly* like light) except that their wavelength is longer. Several experiments have been performed, beginning with the one of Hertz, to prove that the speed of the radio waves was also the same as the speed of light. These experiments have shown that this is true—within the limits of experimental error. This last phrase is the joker. The limits of experimental error in the measurement of radio speeds have been too wide. It has remained possible that the speed of radio might not be *exactly* the speed of light.

The difference, were any found, could scarcely be important in practice. Undoubtedly the speed of radio is ample for all useful purposes. But there are theoretical reasons why scientists want to know for certain and so a recent experiment was organized between Washington, D. C., and Poland.

This experiment was demonstrated recently before a gathering of scientists in the Cosmos Club, at Washington, by Captain R. H. Ranger of the Radio Corporation of America.* From a transmitting key operated by Captain Ranger in the meeting room an electric impulse was sent by land wire to the transmitting station of the Radio Corporation at New Brunswick, New Jersey; thence by radio to the receiving station at Warsaw, Poland; thence by land wire to the Polish transmitting station; thence by radio back again to Riverhead, Long Island; and thence by another land wire to a receiver on the same table as the transmitter in the Washington lecture room. The time needed for the circuit was .046 second.

The same experiment was carried out again at the Bureau of Standards with the most precise measuring instruments. When allowances were made for the effects of the land-wire portions of the circuits and for all other disturbances, the speed of the radio waves worked out to be very close to its theoretical value. Doubtless further refinements of the apparatus, especially the elimination of all the land lines, will give us before long a definite proof that radio does have *exactly* the speed of light.

The Best Kind of Ground Connection

IT is remarkable how little quantitative data exists concerning some points of radio engineering that have great practical importance. One of these points is the efficiency of different types of grounds. Most of the information about this is general information; useful enough, no doubt, but easily improvable in quantitative accuracy.

One bit of quantitative work on this subject has appeared recently.† Experiments at Baden, Germany, reported to the Swiss Association of Electricians, show the great differences in the ground resistance produced by the nature of the soil and by the shape of the ground-plate.

In gravelly soil, a plate of copper about two feet square, surrounded by a little garden soil, showed a resistance of from 100 to 163 ohms. The same plate surrounded by charcoal instead of by garden soil had a resistance of 154 to 264 ohms. A copper ribbon about ⅛ inch wide and 60 feet long, buried in the same garden soil had the much lower resistance of from 25 to 61 ohms.

The greatest difference came, however, when the soil of the neighborhood was clay instead of gravel. In this case the resistance shown by a copper ground-plate surrounded by charcoal was only 11 to 17 ohms; while the long

* "The Importance of the Amateur," by W. H. Eccles, an address to the Radio Society of Great Britain, January 23, 1924. Printed in the *Wireless World* (London), vol. 13, pages 620-623 (February 13, 1924).

* It is described by Carl H. Butman in his *Washington Radio Service* for the week ending March 17, 1924.

† Experiments of Schiesser, quoted from Bulletin No. 8 of the *Association Suisse des Electriciens* in *Annales des Postes, Télégraphes et Téléphones* (Paris), vol. 13, page 195 (February, 1924).

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Bureau of Standards

SHOULD AMATEURS BE ALLOWED TO WORK WITH THIS ANTENNA?

This is the antenna and receiving set used by the engineers of the United States Bureau of Standards in their experiments with radio transmission at a wavelength of 10 meters. The tuned vertical wire serves to pick up the received energy. Many radio engineers are now urging that qualified amateurs should be permitted to experiment with these unusually short wavelengths.

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copper ribbon showed the still smaller resistance of 3.25 to 5 ohms.

The more usual type of ground, three six-foot iron rods driven completely down into the soil at the points of a triangle six feet on each side, gave a resistance of 4.5 to 7 ohms.

Does the Sun Act Like the Filament of a Vacuum Tube?

SCIENTIST'S have suspected for some time that the sun is a great astronomic source of electrons, that uncountable billions of these electrons are driven off from the hot sun every second, just as the electrons are driven out of the hot filament of a vacuum tube. Some of these electrons are received by the earth. There is, therefore, a real analogy between the solar system and our familiar vacuum tubes.

The sun represents the filament. It is a source of electrons. The earth represents the plate; it receives the electrons. The empty space between us and the sun represents the vacuum of the tube.

This solar vacuum tube has a multiplicity of plates, one for each of the planets. There is another difference in that the plates are not connected by wire conductors either with each other or with the filament, that is, with the sun. Nor is there in the astronomic system any visible analogy to the grid.

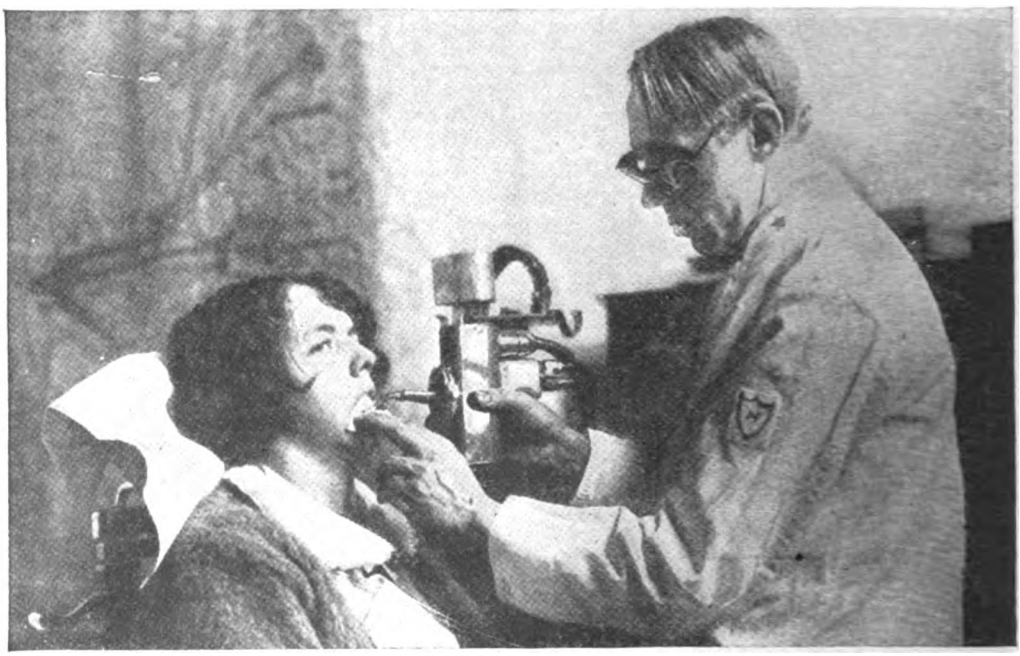
But in spite of these obvious differences, the analogies are considerable. For example, the rules worked out for the space charge in a vacuum tube probably apply quite well (of course, with the proper modifications) to the electric conditions between the earth and the sun.

One of the deductions from these ideas is the theory that there must be a layer of free electrons, a kind of "electron gas," immediately around the sun. We know that there is such an atmosphere of electrons around the glowing filament of a vacuum tube whenever the electrons are not drained away too rapidly by a positively charged plate.

Over a year ago Dr. J. Q. Stewart of Princeton University suggested the existence of such an atmosphere of free electrons around the sun.* He suggested, also, that this layer of electron gas would be thick enough and dense enough to be opaque to light. It follows that we do not see the real sun at all. We cannot see it. All that we see are the shining geysers of hot gas that manage to get high enough above the real surface of the sun to shine through the great cloud of electrons that surround it. It is as though the electrons in a vacuum tube escaped so thickly that they entirely hid the visible glow of the filament.

More recently Professor A. H. Compton,

* "Opacity of an Ionized Gas," by John Q. Stewart, *Nature* (London), vol. 111, page 186 (February 10, 1923). There is a more complete report in the *Physical Review*, vol. 22, pages 324-332 (October, 1923).



International

ETHER WAVES TO CURE YOUR TOOTHACHE

This apparatus, developed by Dr. E. C. Cummings of the Harvard Dental School, produces ultra-violet light in the patient's mouth so that this form of ether waves, waves still shorter than those of light, can be applied directly to diseased tissue.

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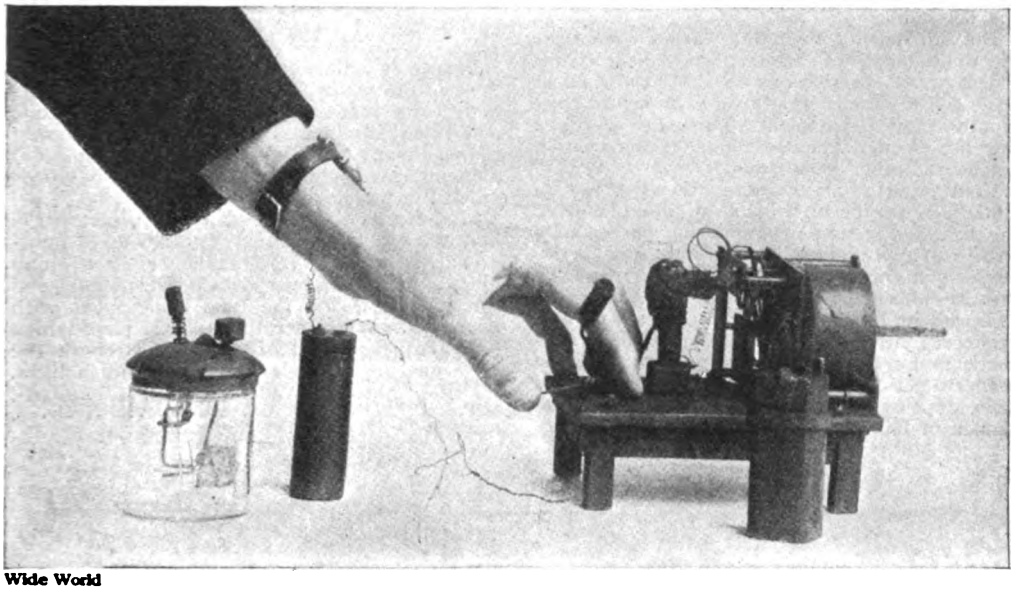

Wide World

THE ADAM OF RADIO SETS

This apparatus, recently found in London, is the original set used by David Hughes, the inventor of the first detector, in his radio experiments made in 1879. The transmitter is at the right and the receiver, made of knitting needles, corks and other odds and ends, is shown at the left. It is still in working order.

of Washington University, St. Louis, has found a direct indication that the sun is surrounded by electrons.* He has shown, from theoretical considerations as well as from experiment, that a cloud of free electrons will affect light that passes through it in such a way as to alter the wavelength of a part of the light. This is what scientists call the "scattering" effect. And it appears that the light from near the edge of the sun's disk, which light would traverse a great thickness of the supposed electron atmosphere, shows just this scattering effect that it ought to show if the atmosphere of electrons is really there.

To the radio public these new discoveries have not only the interest that any discovery about the sun must have for all of us who live by its light and warmth; they have, also, a direct importance to radio.

There remains no doubt at all that the electric properties of the sun, especially the electrons and other charged particles that are shot out from it, are factors of the greatest importance in radio transmission on earth. When we have succeeded in learning more accurately just what the sun is doing, just what is the space charge of electrons around it, just how many electrons are projected with sufficient velocities to reach the "plate" of the solar vacuum tube, that is, the earth; then we shall have gone a long way toward solving the mysteries of fading, of the effect of the Heaviside Layer, of the absorption of long-distance radio waves, and many others.

Like life itself, many of the phenomena of radio are regulated by things that happen on the sun nearly a hundred million miles away. Solar astronomy is one of the important branches of radio science.

A Discovery of Value to Radio in 1827

THE March, 1924, issue of that invaluable publication, the *Radio Service Bulletin*, issued by the United States Department of Commerce,* contains an interesting list of some of the great inventions and achievements that have marked important turning points in the development of radio. One might call them the "fifteen decisive battles of radio," except that there are many more than fifteen and that most of them were not so much "battles" as long sieges, the successful result coming only after years of laborious endeavor.

The first date cited by the compiler of this list is nearly a hundred years ago. In 1827, he writes, Savary discovered that a steel needle could be magnetized by an electric discharge. It was four years later, in 1831, that the Irish genius, Michael Faraday, the man who began as a bottle washer and ended as the greatest scientist of his time, discovered the principles of electromagnetism. It is from

* "Absorption Measurements of the Change of Wavelength Accompanying the Scattering of X Rays," by A. H. Compton, *Philosophical Magazine* (London), vol. 46, pages 897-911 (November, 1923).

* Every radio fan should be a subscriber to this publication. It costs only 25 cents a year, remitted to the Superintendent of Documents, Washington, D. C.

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this latter event that most writers have dated the beginnings of radio.

But still earlier than this, earlier even than the experiments of Savary, were the recently rediscovered observations of Biot published in 1819, observations that were described last month in this Department. This work of Biot's the list in the *Bulletin* omits from mention among the other pioneers.

Continuing from Faraday, the list in the ***Bulletin*** notes the high points of radio history; the first production of oscillating currents by Professor Henry in 1840, Lindsay's first "wireless" signalling (by water conduction) in 1845, the announcement of the ether-wave theory by Maxwell in 1867, the original detector or first "coherer" invented by Hughes in 1879, Dolbear's first real radio in 1882, and, entering the modern period, the experiments of Hertz in 1886, of Marconi in 1897 to 1900 and of Fessenden in 1901.

A Simple Way to Map Electric Lines of Force

SEEING is believing, and the best way to believe in the reality of the fields of electromagnetic force that are supposed to surround coils and other conductors is to devise some way to *see* them. So thinks the well-known radio amateur, Mr. John Reinartz, and he has provided the way to do it.*

His apparatus is the familiar neon spark-indicator used for testing the behavior of automobile spark plugs. This is merely a small glass tube containing two electrodes sealed through the glass, the tube being filled with neon gas. Whenever this tube is placed in a high-frequency field of sufficient strength the neon gas inside it glows with a reddish light.

* "How Antennas Work," by John L. Reinartz, 1QP. *QST* (Hartford, Connecticut), vol. 7, No. 8, pages 16-19 (March, 1924).

From a photograph made for POPULAR RADIO by Hoppé, London

A LOUDSPEAKER THAT OPERATES ON A NEW PRINCIPLE

Mr. S. G. Brown, F. R. S., of London, is the inventor of the "frenophone," a loud-speaker which may be used in connection with a crystal set. The necessary amplification of the sound comes from the friction of a small vertical rod against a rotating glass disk. Both rod and disk are visible in the phonograph. The principle of the frenophone was described in POPULAR RADIO ***for January, 1924, on page 94.***

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CONDUCTED BY RICHARD LORD

A limited number of questions of general scientific interest will be answered each month in this department. Readers are invited to send in questions that have puzzled them—but the selection of questions for answer cannot be guaranteed nor can questions outside the radio field be answered by mail.

How does the temperature of the filament in a vacuum tube affect its operation?

IT determines the number of electrons that are set free from second to second by the filament and which serve as the carriers of the current in the tube from the filament to the plate. There are always a great many loose electrons inside all metals, including the metal wire of the filament. When the wire is cold these electrons stay inside it but when it gets hot they jostle each other around so much that some of them are forced out of the wire altogether and thus provide the electrons for the working of the tube. The hotter the wire the more electrons are forced out.

Is liquid air used in filling vacuum tubes? And how is it made?

Liquid air is not used as a material for filling vacuum tubes, but it has been used in laboratories in experiments on making a nearly perfect vacuum (See POPULAR RADIO for October, 1922, page 92). It is used merely as a cooling agent to condense vapors that you do not want to get into the tube. With liquid air it is possible to obtain a temperature of 250 or 300 degrees below zero Fahrenheit. Liquid air is made by cooling ordinary air intensely This is accomplished by a succession of alternate compressions and expansions, each expansion making the air a little colder.

What is the difference between synthetic and natural crystals?

NATURAL crystals are those that are found ready formed in the rocks. Naural galena, for example, is a crystal of sulphide of lead, formed in the course of geologic ages in the mineral vein and now dug out by the miners. It is a common ore of lead and also of silver, since it frequently contains that metal as an impurity. Pyrite, another mineral sometimes used as a natural radio crystal, is a natural sulphide of iron formerly much used as a source of sulphuric acid. Synthetic crystals, on the other hand, are artificial mixtures of compounds made in the laboratory. They have many different chemical and physical compositions depending on the formula used in making them.

What are the harmonics of a broadcasting wave? I am told that some stations send out many harmonics and that that makes their waves hard to receive.

HARMONICS are the higher frequencies, representing exact multiples of the fundamental frequency. For example, suppose a station is sending on a wavelength of 600 meters, which is a frequency of 500 kilocycles. This is then the fundamental wave (or frequency). But if the antenna arrangements are bad, or for many other reasons, the wave actually sent out may contain also a frequency of *twice* 500 kilocycles, or 1,000 kilocycles, which corresponds to 300 meters. This is the "first harmonic." Similarly there might be also a frequency of 3 times 500 kilocycles, or 1,500 kilocycles, corresponding to 200 meters. This would be the second harmonic. There would be a third at 2,000 kilocycles or 150 meters, a fourth at 2,500 kilocycles or 125 meters, and so on. Of course, all broadcasting stations try to keep their sending wave as "pure" as possible, that is to avoid producing these harmonics.

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How can you calculate the amount of heat produced in a wire by an electric current?

THE heating effect increases with the square of the current that is flowing and in direct proportion to the resistance of the wire. If you measure the current in amperes and the resistance in ohms you can calculate the amount of heat produced by the following rule:

Take the square of the current, multiply this by the resistance, then multiply the product by the fraction .2389. This will give you the number of calories of heat being produced a second—one calorie being the amount of heat required to heat one gram of water one degree Centigrade. This is a very small quantity of heat. The burning of one grain of coal will produce about 500 times this much.

How do they make the thin sheets of mica that are used in condensers?

THESE sheets are made by nature, not by man. Mica is a natural mineral containing somewhat variable percentages of four chemical elements: potassium, aluminum, silicon and oxygen. Chemists call it a silicate of aluminum and potassium. When mica crystallizes in the rocks the atoms in it arrange themselves so they will split apart much more easily in some directions than in others. This makes it easy to split off the thin sheets used in condensers. The original use of these mica sheets was in making the little windows that used to be put in the doors of coal stoves so that one could see the fire without opening the door.

What is the difference between the Centigrade thermometer used in scientific work and the ordinary thermometer?

ALL thermometer scales are purely arbitrary. When the Fahrenheit scale (commonly used in the United States) was first designed, its zero point was set at what was then believed to be the lowest temperature ever experienced on earth and its 100 degree mark at the highest. The scientific or Centigrade scale has its zero at the melting point of ice and its 100 degree mark at the boiling point of water. Zero Centigrade is the same as 32 degrees Fahrenheit. To convert a Centigrade temperature into a Fahrenheit one multiply by 9/5 and add 32. To convert Fahrenheit into Centigrade subtract 32 and multiply the remainder by 5/9.

Are the electric sparks produced when you stroke a cat's fur the same as other kinds of electricity or different?

THEY are the same. They are, in fact, a manifestation of frictional or static electricity, the same as is produced when you rub a glass or rubber rod on cloth. The friction detaches some electrons from one of the objects that are being rubbed together. These electrons accumulate on the other object, either the cloth or the rod, and produce a charge on it. When you get enough charge a small spark occurs, as it does on the cat's back.

I am told that I can test my headphones with a copper penny. How is this done?

WHAT you refer to, probably, is a way of making a small electric battery with a penny and another coin, preferably a nickel. Connect one terminal of the headphone to the penny, the other terminal to the nickel. Then touch both coins to a piece of blotting paper wetted thoroughly with a little weak vinegar. There will be a faint click in the phones when the coins touch the paper. But this is not a very dependable test for the quality of a telephone. It is better to test all the characteristics of a telephone by the standard electrical methods. If you lack the experience to do this, better buy a standard make of telephone having known characteristics.

What are isotopes?

THIS is a name for certain chemical elements which are really different though they seem very much alike. For example, there are at least five different varieties of lead. All of them look alike and have exactly the same chemical properties. You cannot tell them apart by any chemical method. Yet they differ in one important particular; their atoms have different weights. These five different varieties are called the isotopes of lead. The atom of one isotope weighs 206 units, another weighs 208 units, and so on. This idea of isotopes is very important in modern theories of the structure of atoms. See Sir Joseph Thomson's article in POPULAR RADIO for September, 1923.

Why is iron magnetic and other metals not magnetic?

THIS is really a good deal of a mystery; the theory of magnetism not being very well understood. Most scientists believe that iron is magnetic because the iron atoms are themselves little magnets, each one having its own north and south poles just as a bar magnet has. In unmagnetized iron the atoms are arranged irregularly, so that the magnetic effects of the atoms cancel each other. When you magnetize the iron what you do, really, is to turn the atoms around so that all the north poles point in the same direction and reinforce each other. Metals other than iron do not possess, scientists suppose, these little atomic magnets so they cannot be magnetized.

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If you are getting good results with your receiving set, tell your fellow-readers of POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

SET IS GOOD AS WELL AS SIMPLE

A FAN in Canada can hear at least a dozen good stations in various parts of the United States by putting together three of the common instruments which can be purchased in any radio store and using one peanut tube.

Cyril A. Hark, 2517 Mauce Street, Montreal, has made a good double-circuit tuner of the regenerative type by using a variocoupler, variometer and 23-plate condenser. His results were obtained with an antenna only 50 feet long and a 20-foot lead-in.

His list includes KDKA, Pittsburgh, Pa.; WEAF, New York City; WOC, Davenport, Ia.; WTAM, Cleveland, O.; WBZ, Springfield, Mass., and WDAP, Chicago, Ill.

* * *

THIS IS A CHALLENGE

"I CHALLENGE anyone to duplicate my reception on two tubes," is the way the gauntlet is thrown down by John Keiran of 32 Alleyne Street, West Roxbury, Mass. "I have received three English stations during the transatlantic tests, 2LO, 2ZY and 5IT, and have even picked up WNP, the station of the MacMillan arctic expedition, some 700 miles from the North Pole.

"I am using a one-tube regenerative set, with one stage of audio-frequency amplification. I attribute my success to my antenna, which is 100 feet in length and 30 feet above the ground. On a poor antenna, my set will not cover 300 miles. I have received over 100 stations with it in four months."

* * *

THEY DO IT WITH A MIXING BOWL IN SAN FRANCISCO

USING three tubes with six volts on the filament and eighteen on the plate of the detector in the four-circuit tuner, F. N. Bellish of San Francisco hears the local station, KPO, ten feet away from his Baldwin loudspeaker unit in a mixing bowl and both antenna and ground leads disconnected.

ALL WAVES VISIT LAKE HOPATCONG

LAKE HOPATCONG is good for fishing but better for radio listening, according to Edwin Carman of 514 West 168th Street, New York City. He took his Green circuit, which was described in POPULAR RADIO, to the camp for an outing, and learned something about the geography of the United States by checking his stations on a map.

With three tubes he picked up KHJ, Los Angeles, Calif.; WOAW, Omaha, Nebr.; KDZE, Seattle, Wash.; WSAI, Cincinnati, O.; WJAR, Providence, R. I.; 6KW, Cuba; WTAS, Elgin, Ill.; CFAC, Calgary, Canada; WCBD, Zion City, Ill., and WFAA, Dallas, Texas.

"Half of these stations were heard on an old-fashioned phonograph horn to which my phones were clamped," he states. "I have made one change in the circuit by tapping my coil at the following turns, 15, 35, 65, 85 and 105."

* * *

TWO DOZEN IN A WEEK

"I BUILT the Haynes DX receiver one week ago and have so far received twenty-four stations," writes Linden E. Crone of 667 South Seventh East Street, Salt Lake City, Utah.

"I am using a repaired WD-11 tube. My antenna is 90 feet long and 30 feet high."

Among his record stations are CHCB, Toronto, Canada; KDKA, Pittsburgh, Pa.; WBAP, Fort Worth, Tex.; KPO, San Francisco, Calif., and KFEC, Portland, Ore.

* * *

WHAT AN UMBRELLA CAN DO

THE distance between San Francisco, Calif., and Calgary, Canada, was spanned with one tube in the triple honeycomb-coil circuit described in the September issue, using the umbrella antenna which appeared in the same number.

"The music was distinct and clear," writes Matt. A. Gracin, the man who did it.

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ONE TUBE CATCHES 92 STATIONS

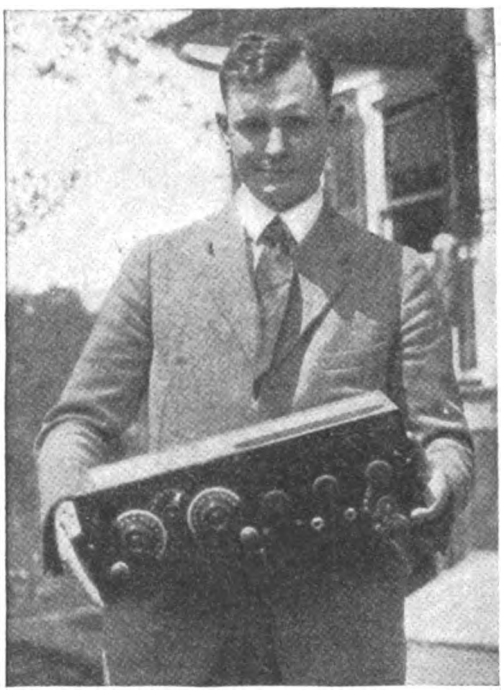
NINETY-TWO stations have been logged by Harold B. Taylor of Atlanta, Ga., using three spider-web coils in a regenerative double circuit and one dry-cell tube. His antenna is a single wire 164 feet long and 40 feet high.

Among those he hears are KOG, Los Angeles, Cal.; KFDL, Denver, Colo.; WHA, Madison, Wis.; WLW, Cincinnati, O.; WCX, Detroit, Mich.; WOAN, Lawrenceburg, Tenn.; WAAP, Wichita, Kan.; WQAA, Parkersburg, Penn.; WEAY, Houston, Tex.; WOAF, Tyler, Tex.; WAAY Youngstown, O.; WAAC, New Orleans, La.; WNAV, Knoxville, Tenn.; WIAG, Birmingham, Ala.; 9CAO, Rockport, Mo.; WPA, Fort Worth, Tex.; WIAO, Milwaukee, Wis.; WHAB, Galveston, Tex., and so many more that his letter looks like several pages taken from a call book.

* * *

750 MILES WITH A CRYSTAL

DUDLEY JOHNSON of Oak Bay, Victoria, B. C., Canada, has heard San Francisco on his crystal set, a distance of 750 miles. The station was KPO, and it came in clear and loud.



THIS SET SPANNED THE UNITED STATES

This four-circuit tuner spanned the distance between Canada and Texas during the first five minutes it was operated. G. A. Foster, who built it from instructions published in POPULAR RADIO, *lives in Keewaydin Camp, Timagami, Ont., Canada.*

"I owe you this letter," he writes, "for I made my set from the description in the July issue of POPULAR RADIO last summer; besides KPO I have been hearing the nearer stations constantly."

* * *

A FIRST NIGHT PERFORMANCE ON THE REAL DX SET

WITH the Real DX Regenerative Receiver described on page 281 of the April issue of POPULAR RADIO, J. V. Trammel of Swenson, Texas, heard stations in Omaha, Nebraska, 750 miles distant, Memphis, Tenn., 900 miles distant, and Los Angeles, Cal., 1,100 miles distant, on the first night that his set was in operation.

* * *

SIMPLE SET SURPRISES HIM

WITH only a coil, a crystal, and a pair of phones, Frank Kosmata of Cicero, Ill., made the set described in the June number of POPULAR RADIO and connected it to a 50-foot antenna with results which startled him. He heard nine stations in Chicago, Ill.

* * *

PATIENCE MAKES CIRCUIT WORK

"AT first I was unable to make the four-circuit tuner work," writes C. A. Campbell of Watertown, N. Y., "but after a few minor changes, the results exceeded my expectations."

"I am using an antenna of only 40 feet, with a lead-in of about the same length. By connecting the single-turn wire of the primary to the top tap on the bank-wound coil and by using a 200-ohm potentiometer across my "A" battery with the negative "B" on the arm, I have been able to reach nearly every broadcasting station of importance in the eastern part of the country. Stations WBZ, WHAS, WGR, WDAP and WSAI can easily be worked on a loudspeaker in summer weather."

HE IS LISTENING TO KFI

"I WANT to say," writes R. L. Walker of San Francisco, Calif., "that the hook-up in POPULAR RADIO for June, page 429, is surely a dandy. I can hear it all over the room with one tube and with one step of audio-frequency amplification I can not keep the head phones on. I am listening now to KFI, Los Angeles, over 500 miles away."

* * *

ONE TUBE AND AN OLD STAND-BY

THE popular old circuit employing two variometers and a variocoupler covers nineteen states with one tube for Laurel Carpenter of Bowling Green, O. He also uses two variable condensers which enable him to tune closer and to cut out much interference.

His list includes PWX, Havana, Cuba; WBZ, Springfield, Mass.; WJZ, Newark, N. J.; WEAF, New York City; KDKA, Pittsburgh, Pa.; WJAX, Cleveland, O.; WHAS, Louisville, KY.; WWJ, Detroit, Mich.; WDAP, Chicago, Ill.; WHB, Kansas City, Kans.; WFAA, Dallas, Tex.; WIAO, Milwaukee, Wis.; WMC, Memphis, Tenn.; WBT, Charlotte, N. C.; WLK, Indianapolis, Ind., and WCK, St. Louis, Mo. His list totals 65.

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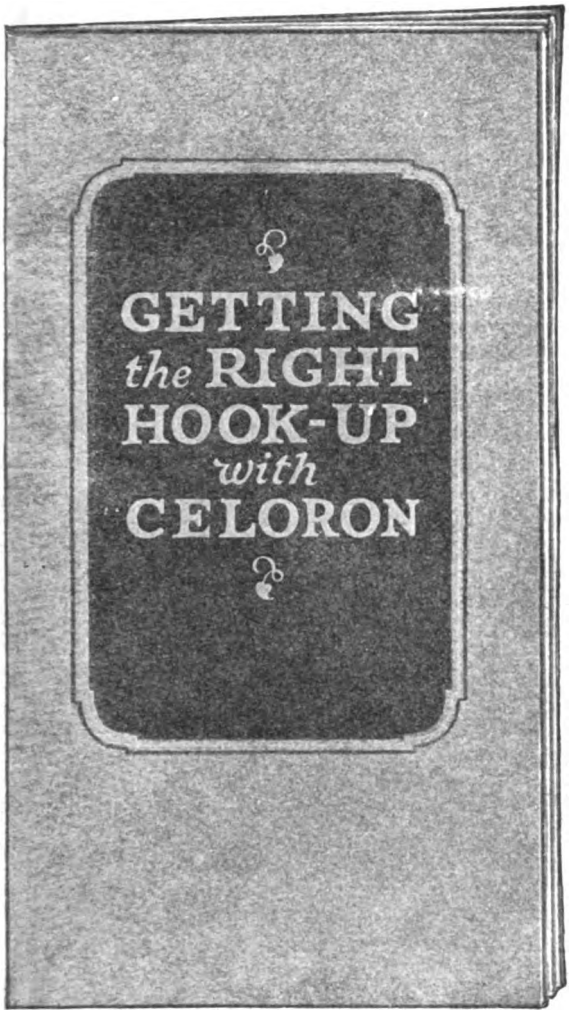

The right hook-up for you

WHAT'S the first thing to do in building a radio set? What hook-up is particularly efficient for getting local stations—for getting DX? What do the different radio symbols and terms mean?

We have prepared for free distribution a booklet that answers these questions and others connected with the building and operation of a set. It is called "Getting the Right Hook-up with Celoron." It contains diagrams of ten highly efficient receivers, ranging from a crystal to a superheterodyne.

This booklet has been carefully designed for the set-builder. In it are hints and suggestions about selecting a panel and parts, and tips on tuning and on getting clear reception.

The edition of this booklet is limited. So mail the coupon today. It won't cost you a cent. But you must act at once.

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Please send me without charge a copy of the booklet, "Getting the Right Hook-up with Celoron." My radio dealer's name is

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The most efficient dials and sockets are made from Bakelite, the world's foremost insulating material. Our experience as one of the country's oldest molders of Bakelite is one of the reasons why BELL Sockets and Dials make good wherever used.

The BELL Dial

Highly polished. Clean, white engraving. Accurate brass bushings that will not wabble on the shaft. Strong mechanically, and unaffected by moisture and temperature. Color will not fade. In 2, 3, 3½ and 4 inch sizes. Made also with hole through knob for vernier attachment. Vernier knob to match can be supplied.

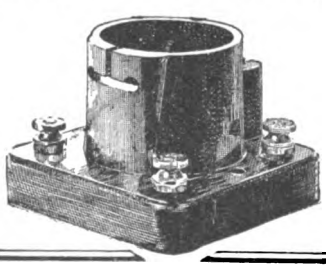
The BELL Square Socket

One-piece molded Bakelite, for base or panel mounting. Unusual double-wipe spring contact makes firm, sure contact with tube prongs, even after constant use. Use it to get best results.

Dealers: If your jobber does not have BELL Radio Products, write us for circular on molded sockets and dials.

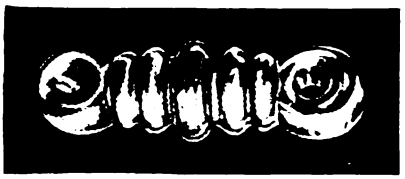
Bell Manufacturing Co.

12 Elkins St. Boston 27, Mass.



The BELL Square Socket

Give Your Set a Chance



USE PYREX INSULATORS ON YOUR ANTENNA

John L. Reinartz uses Pyrex Insulators and says:

"They deserve a good share of the credit for reliable transmission to France, England and Holland."

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AT ALL GOOD DEALERS

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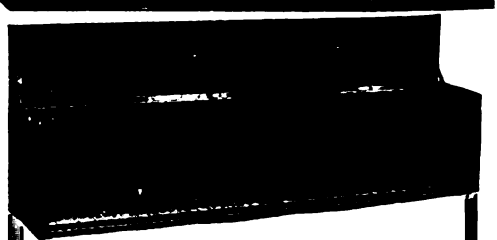

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And Now Super Radio Cabinets

Panel size 8 x 40-8 inches deep. Made of solid select mahogany with basswood bottom, varnished and hand rubbed to a piano finish. Built by experienced workmen—experts on cabinet design and construction.

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Also Neutrodyne sizes, 7 x 24-7" and 7 x 26-7". Smaller sizes, 7 x 14-7", 7 x 18-7" and 7 x 21-7". Write for illustrated price list and name of your nearest jobber or dealer.

Jobbers and dealers, write for discounts

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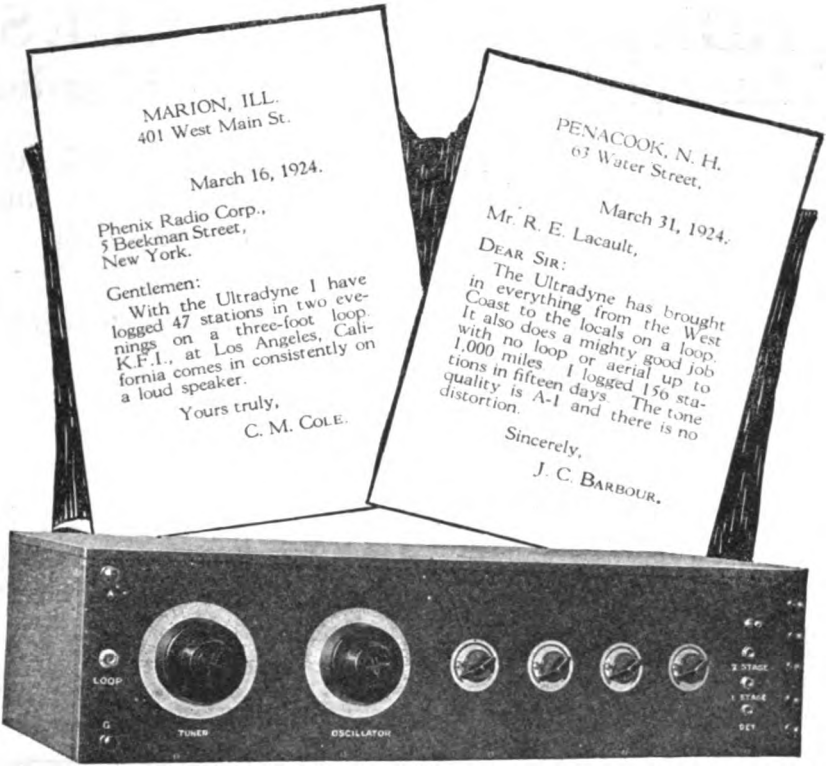
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Gentlemen:
With the Ultradyne I have logged 47 stations in two evenings on a three-foot loop. K.F.I., at Los Angeles, California comes in consistently on a loud speaker.
Yours truly,
C. M. COLE.
PENACOOK, N. H.
63 Water Street,
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Mr. R. E. Lacault,
DEAR SIR:
The Ultradyne has brought in everything from the West Coast to the locals on a loop. It also does a mighty good job with no loop or aerial up to 1,000 miles. I logged 156 stations in fifteen days. The tone quality is A-1 and there is no distortion.
Sincerely,
J. C. BARBOUR.
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TUNER
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2 STAGE
1 STAGE
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R. E. Lacault

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The "Modulation System" places the Ultradyne years ahead of all present methods of radio reception. This new principle increases the sensitiveness over that of any known receiver. Weakest signals are made to operate the loud speaker.

Results secured by Ultradyne owners are amazing and exceed even those obtained with any other receiver under the same conditions. For range, signal audibility and faithful performance, the Ultradyne commands your first consideration.

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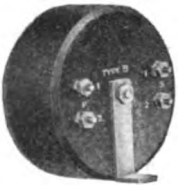

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Types "A" and "B"

New improved long wave radio frequency transformers. Type "E" may be successfully employed in any circuit where long wave radio frequency transformers are essential.

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R. E. Lacault

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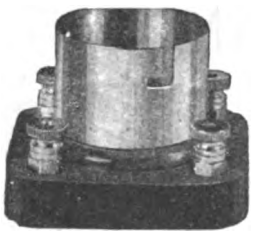

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With 6 ft. cord

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Send me the *Needlephone*. I'll pay the postman $10 upon its arrival. It is distinctly understood I may return it if I desire, within 5 days and receive a refund in full.

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***Radio and Electrical Products**

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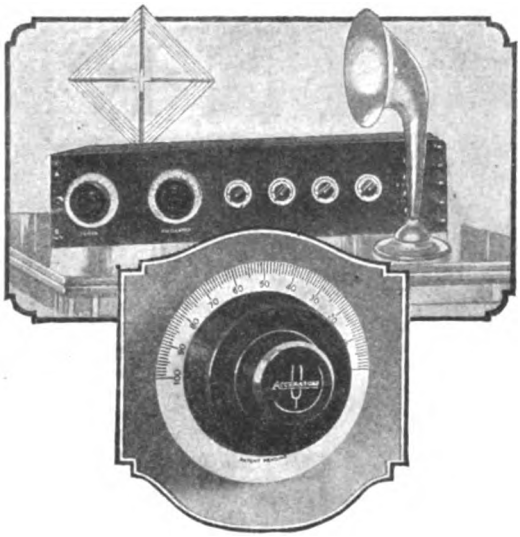

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On Ultradyne and Super-Heterodyne receivers, in which close tuning apparatus is employed, engineers recommend micrometer controls in preference to ordinary dials. R. E. Lacault, A.M.I.R.E., designer of the famous Ultradyne, recommends only the Accuratune Micrometer Tuning Control for use with this set.

The Accuratune is not a mere dial, but an actual micrometer tuning control, very responsive to the slightest touch of the micrometer knob and ten times more efficient than any other tuning device. Stations that have never been heard before are brought in clearly when tuned with the Accuratune.

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DISTANCE!

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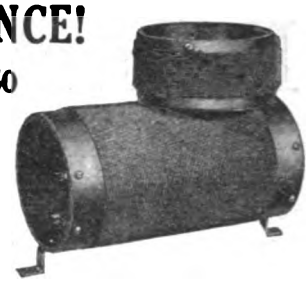

The Only Authorized Cockaday Coil

Gets distant stations easily and clearly. Hundreds have substituted this quality coil for those of inferior make, and are amazed at the improved reception, selectivity and general D-X results.

Y. M. C. A. Secretary, Wilmerding, Pa., says, "We've been getting KHJ in Los Angeles on three tubes (WD-11) but since installing your coils we now get KHJ on the detector alone, a distance of 2300 miles, and much clearer."

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HOWARD

No. 1004
Multi Terminal Receiver Plug, instantaneous connection for as many as six pairs of standard receiver tips..... $2.00
Patd. Aug. 28, 1923

HOWARD RADIO CO., Inc.

4248 North Western Ave., Chicago, U. S. A.

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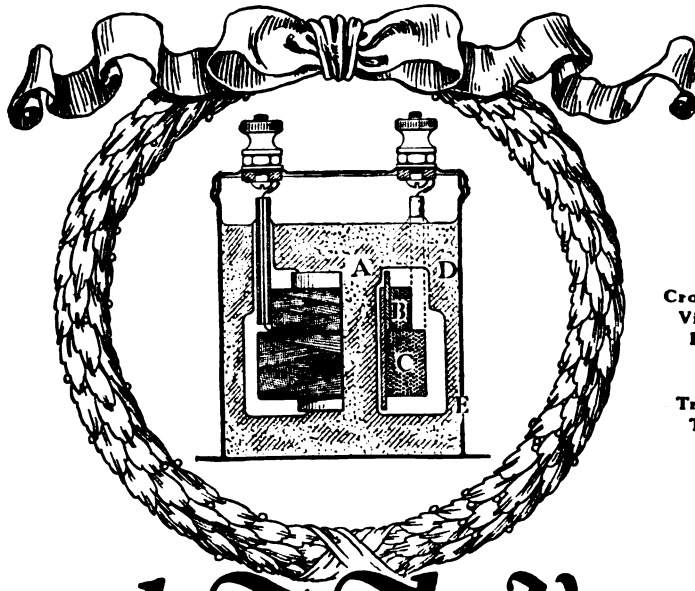

Cross Section View of the Receptrad Long Wave Transformer Type 1716

Laurels To The Victor!

The design of a perfected intermediate frequency amplifying transformer for use in Super-Heterodyne or long wave length amplification is a task calling for unusual engineering skill. In the type 1716 developed by RECEPTRAD engineers, it will be seen that unusual skill has been displayed in solving this most important unit in Supercircuits.

The special core A, is of comunited iron and forms a closed field. The primary B, is so wound with respect to the secondary C, that it affords the maximum step-up in signal voltage. Both are "Herring Bone Winding," a patented type used only by RECEPTRAD. The field is further shielded by a magnetic path D, and is metallically isolated from external fields by the case E.

The RECEPTRAD transformer is a victory for the steel core type but a greater victory for Receptrad because its efficiency exceeds by far any similar intermediate frequency coupler.

Further Engineering data sent on request.

Other RECEPTRAD Super Parts:

THE SUPER-HETERODYNE MANUAL by Lieut. Victor Greiff **$1.50**
Written by Victor Greiff, giving the fullest details and explanations on theory and practice. Includes three full size blue prints for panels, drilling, circuit, etc. The only complete and authoritative text-book on the subject.

TRANSFORMER, TYPE 1716 (Long Wave) **$8.50**
Used in the Intermediate Frequency Amplifier. Covers frequencies from 5,000 to 25,000 meters. Self shielding Steel core guarantees power and stability.

OSCILLO-COUPLER, TYPE SW-21 ..... **$6.00**
Covers wave lengths between 200 and 750 meters.

FILTER-COUPLER, TYPE H-34 ..... **$7.50**
Special Construction, Herring Bone winding; Sharply tuned.

TRANSFORMERS, TYPE ATX AND AT3, high efficiency, clear toned for First and Second step audio. **$5.75**

If your dealer cannot supply you, forward remittance and you will be supplied direct.

RR Co. PRODUCTS **RADIO RECEPTOR CO.** RR Co. PRODUCTS

57 Bank Street **New York City**

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"37 stations heard in one night"

"IF anything is good, I sure believe in praising it—and I can't begin to praise your Shamrock Kit enough . . .

"I am enclosing the original list taken Thursday, February 28, 1924 (37 stations heard). At all times at least two Chicago stations were on . . . "

A few of the distant stations tuned in—WOR, Newark; WSB, Atlanta; WEAP, Ft. Worth; CKCK, Regina, Can.; KHJ, Los Angeles; KGW, Portland; WKAQ, San Juan, P. R.

List price $20

The above is only one of hundreds of letters we have received praising the remarkable efficiency of the Shamrock Kit. Inspect this kit at your dealer's today. If he hasn't it in stock, send us the coupon below.

SHAMROCK MANUFACTURING CO.
Dept. 91, Market St., Newark, N. J.

SHAMROCK
FOR SELECTIVE TUNING

MAIL THIS COUPON

SHAMROCK MFG. CO.,
Dept. 91, Market St., Newark, N. J.

Gentlemen:
Send me information on your Shamrock Kit.

Name.....

Address.....

Dealer's Name.....

An Expert Says:

Resistance Coupled Amplification

G. Y. Allen, of the Westinghouse Electric and Manufacturing Co., writes in the May *Radio Broadcast:*

"True, great improvements have been made, but the fact remains that fundamentally the transformer cannot ever give distortionless amplification. For those who demand quality at all cost, the resistance coupled amplifier is unquestionably the most desirable."

"Cost" is no longer a drawback. Daven specialized resistance coupled amplifier parts have cut the price to less than $3.00 per stage.

Special inexpensive resistors from 5,000 ohms up. Our RESISTO-COUPLER, to hold resistor, leak and condenser.....$1.50

Ask your dealer—or let us help you out

DAVEN RADIO COMPANY

"Resistor Specialists"

9 Campbell Street :: Newark, N. J.

COAST TO COAST

on the R.C.S Circuit, using RayCoilS

RayCoilS "A" for Reinartz, RayCoilS "B" for RCS and Ultra Audion Circuits, RayCoilS "C" for RCS, Ultra Audion and Tuned Radio Frequency Circuits. RayCoilS "D" for Tuned Radio Frequency and Neutralizing Circuits of 4, 5 and 6 Tubes.

A = $2.50
B = 2.00
C = 2.00
D = 2.00

Use the RCS Circuit with or without Radio Frequency for Simplicity in operation and results. Not equalled by any set for volume and distance.

Coils in Separate Box
With Wiring Diagram

Working Blue Prints of four sheets 12 x 18 of all standard circuits, as Variometer Hookup, Reinartz one and three tube, R.C.S. three and four tube and R.C.S. five tube Tuned Radio Frequency, 50 cents a set.

We also carry a complete line of Carter, Howard, Kellogg, Modern and Trimm parts.

If your dealer cannot supply you, we will mail direct.

R. C. SCHOONHOVEN

Major Q. M. R. C.

310 SENECA ST. ELGIN, ILL.

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—To the man who buys his radio "*ready made*"

These set makers use ACME *Transformers*

THE BRISTOL CO. WM. J. MURDOCK CO. POWR RADIO CO.
AMPLIFEX RADIO CORP. PENN. WIRELESS MFG. CO. SEARS MANUFACTURING CO.
SLEEPER RADIO CO. STANWOOD ELECTRIC SPECIALTY CO.

WHEN you buy a radio set, choose one which uses Acme Amplifying Transformers. Amplification is the key to radio. Amplification builds up the tiny sound waves that reach your set and makes them loud enough for you to hear. To hear radio "loud and clear," be sure to have transformers that give maximum amplification without distorting the sound. Distortion makes squeals and howls out of broadcasting that should be clear and distinct.

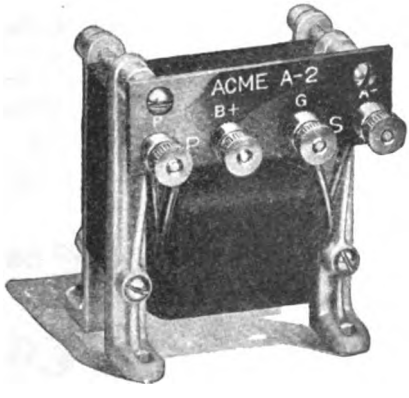
How to get amplification without distortion

THE Acme Apparatus Company, specializing in the manufacture of transformers, has perfected amplifying transformers which are famous among radio owners for giving the greatest amplification without distortion. Eight manufacturers of complete sets use Acme transformers for best results. Thousands of amateurs who have built their own, insist on Acme to be sure of getting the greatest possible range and getting it "loud and clear."

Send for booklet

SEND for our booklet "Amplification without Distortion" which explains amplification and the importance of using the right amplifying apparatus.

ACME APPARATUS COMPANY, Dept. 44, Cambridge, Mass.



ACME
~for amplification

ACME APPARATUS COMPANY,
Dept. 44, Cambridge, Mass., U. S. A.

Gentlemen: I am enclosing 10 cents (U. S. stamps or coin) for a copy of your book, "Amplification without Distortion."

Name.....

Street.....

City.....State.....

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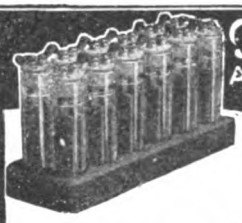


The RāBAT Junior $3.96

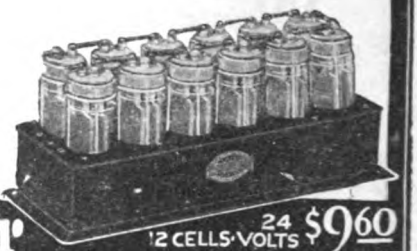
A Rechargeable Wet 'B' Battery. Capacity 800 Mil-Amps.
12 CELLS 24 VOLTS

Your Ultimate "B" Battery

Here are two acid type wet "B" radio batteries that are entirely free from internal current leakage. All elements visible through clear glass cells. RABATS have longer life with higher and more continuous voltage. Noiseless and compactly constructed—The Rabat Junior with a capacity of 800 mil-amps at $3.96 and the Rabat Senior with a capacity of 2800 mil-amps at $9.60 represent more actual battery value at a lower cost. More economical to buy—more economical to maintain. Easily recharged from ordinary house current. If your dealer cannot supply you send direct.

Prices F.O.B. Cleveland, Ohio

The Radio Rabat Company
714 Bangor Building, Cleveland, Ohio



The RāBAT Senior

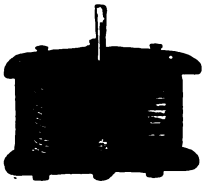
12 CELLS·24 VOLTS $9.60
A Rechargeable Wet 'B' Battery. Capacity 2800 Mil-Amps. 48 VOLTS $17.88

TRADE R.P.C. WESTPORT CONN. MARK

Insist on the Famous

R. P. C.

Non-Microphonic Condenser



$1.50

YOUR dealer will be glad to show you the superior R. P. C. Condensers. Moulded ends—Die cast—Heavy bearings: designed to make tuning quiet and selective for long distance or local work.

23-plate type covers all wave lengths

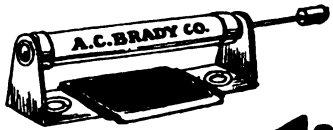
RADIO PRODUCTS COMPANY

Westport, Conn. :: :: :: U. S. A.

The New and Perfect Variable Grid Leak

65¢

Can be installed in any set in a second! Does not change calibration with age or use! Officially adopted for Ultradyne, Polydyne, etc., circuits.



COMPLETE WITH MICA CONDENSER AND PERFECT LEAK MOUNTING $1.00

A.C.BRADY Co.

Improved Radio Apparatus
108-SEVENTH AVE. NEW YORK CITY

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Vincent Lopez and his Hotel Pennsylvania Orchestra

From one who knows

VINCENT LOPEZ praises and endorses the rich, clear, natural quality of MUSIC MASTER reproduction. His Hotel Pennsylvania Orchestra is heard over the radio by untold thousands.

He has enjoyed radio music—mellowed and clarified as it passes through MUSIC MASTER'S amplifying bell of selected wood. His trained ear noted instantly the faithfulness of each re-creation.

MUSIC MASTER is an enduring musical instrument. Hear it and see it at your dealer's or have him send one to be tried and proved with your own set.

Dealers Everywhere

May I say a few words regarding the merits of the Music Master, which to my way of thinking is superlative in its field. For clearness of tone it exceeds any loud speaker which has been brought to my attention, and being directly interested in radio work I consider your product a big achievement and a valuable asset to the radio world.

Please accept my heartiest congratulations.

Sincerely yours,

Vincent Lopez

Exclusive O Keh artist

Music Master Corporation

(Formerly General Radio Corporation)

Makers and Distributors of High-Grade Radio Apparatus

S. W. Cor. 10th and Cherry Streets

Chicago PHILADELPHIA *Pittsburgh*

Music Master RADIO REPRODUCER

14-inch Model, for the Home **$30**

21-inch Model, for Concerts and Dancing **$35**

Connect in place of headphones. No batteries required. No adjustments.

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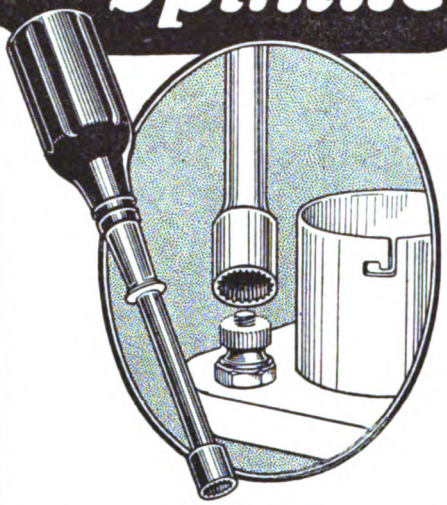
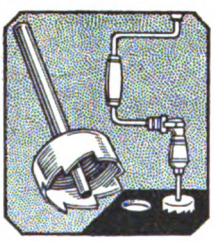
And Now for ROUND nuts *Spintite*



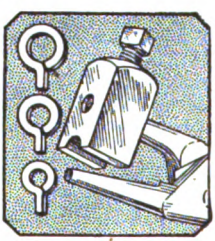
Thousands of radio fans who have been enthusiastic users of Spintite Hex Nut Wrenches have been waiting eagerly for the ***"Round Nut"*** type. The sharp milling on the inside of the ***"Round Nut"*** Spintite holds the nut in a can't-slip grip. With these handy Spintites, ***all*** your connections will be ***as tight as if soldered.***

Set of 3 Spintites for round nuts....$1.00
Set of 3 Spintites for hex nuts..... 1.00
Set of 7 Spintites for *all* hex nuts... 3.50

SPECIAL TOOLS FOR RADIO FANS



Stevens Panel Cutters for making clean cut holes. Sizes, ¾", 75c; 1", 85c; 1½", $1.00.



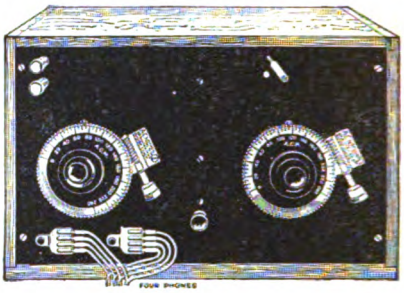
Stevens Speed-a-loop Pliers for quickly bending perfect loop terminals, $1.50.

At your dealer's, or if he can't supply you, send his name and order direct from us. Write for Radio Tools Booklet.

STEVENS & COMPANY
Toolsmiths since 1899
379 Broadway New York

Stevens SPEED UP Tools
TRADE MARK

ACH LONG DISTANCE ONE TUBE SET



$17.50 Mail Orders Only

Price includes Case and Parts, all mounted, ready to wire. No Solder. For Dry Cell Tube.

Including

2 A. C. H. Sharp Tuners.....$5.00
2 A. C. H. 4-Phone Connectors.....25

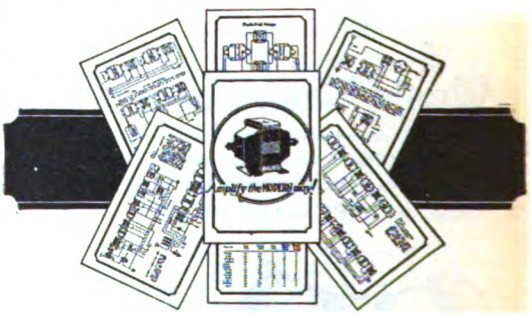
NOTE—$2.00 must be sent with C. O. D. Orders

YES—Use the Wonderful A C H Sharp Tuners

A. C. Hayden Radio & Research Co.
25 E. Battle St., Brockton, Mass., U. S. A.

Send for New MODERN Bulletin of Hook-Ups

This new bulletin, issued by the manufacturers of MODERN "Push-Pull," "Reflex," and Standard Audio Transformers, is distinctly different.



It so thoroughly, yet clearly, illustrates and describes the various hook-ups that any novice can easily build the set he desires without the assistance of some more experienced radio fan.

Your request giving your dealer's name brings this Bulletin by return mail. Send for your copy today.

The Modern Electric Mfg. Co.
Toledo, Ohio

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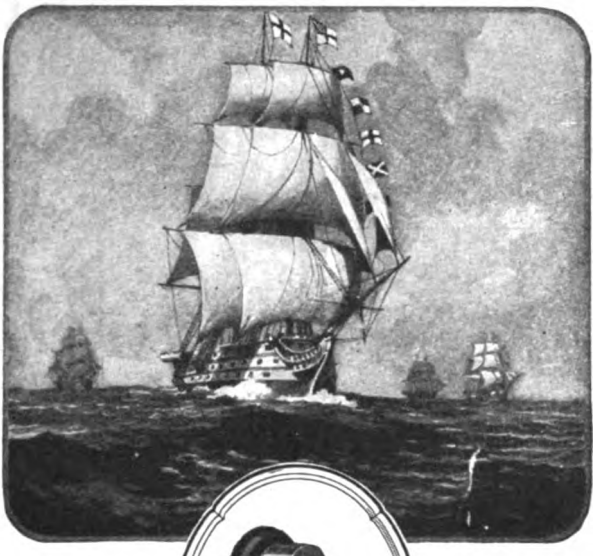

BATTLE OF TRAFALGAR

ON October 21, 1805, Nelson's great naval victory of Trafalgar definitely ended Napoleon's scheme for the invasion of the British Isles. Although in a light breeze the English fleet maneuvered successfully in response to the signals from Nelson's flagship "Victory".

Modern fleets are not dependent upon the uncertainties and limited range of visual signals. Radio which gives us unlimited entertainment through broadcasting also is the modern agency which controls the movements of vessels in battle.

Holzer-Cabot Radio apparatus has added greatly to the development of Radio. Holtzer-Cabot Headsets, Loud Speakers and Phonograph Attachments contain the perfection of design and care in manufacture to enable perfect reception of Radio.

Holtzer-Cabot Loud Speaker	**$25.00**
Loud Speaker Phonograph Attachment	**10.00**
No. 2 Universal Headphones	**9.50**
No. 4 National Headphones	**6.00**

Write for booklets explaining how the exclusive features of these instruments enable you to enjoy the wonders of Radio

THE HOLTZER-CABOT ELECTRIC CO.

125 Amory Street, **Boston, Mass.**
6161-65 South State Street, **Chicago, Ill.**
Department B-1

Holtzer-Cabot

BUSINESS ESTABLISHED 1875

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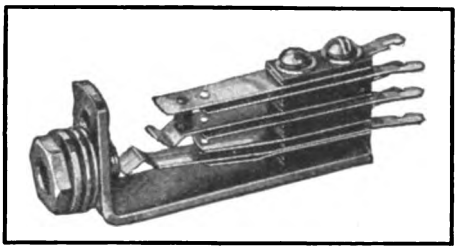


The Leading Jack
PACENT

And in order to keep it always in the lead, improvements are made from time to time to increase its already well known durability and neat appearance.

Some of the recent improvements are listed below together with the now famous "Pacent Jack specifications."

1. A new design of tapered springs greatly improves its neat appearance and contour.
2. Heavier nipple construction, avoids any possibility of stripping threads or breaking.
3. A lock washer in addition to flat washer under the head of assembly screw, increases sturdiness and prevents wear of insulation.
4. Finer Micarta insulation.
5. Entire frame satin nickel finished.

Pacent Jack Specifications in addition to those listed above

Coin silver contacts (riveted to springs).
Genuine German silver springs.
Nickel plated brass frames (not iron).
Extra booster springs.
Lugs fantailed for convenient soldering.
Provided with three washers.
Fits any panel $\frac{1}{8}$" to $\frac{3}{8}$".
All details precisely accurate.
Rugged construction throughout.

There are 10 types of Pacent Jacks—a jack for every circuit.

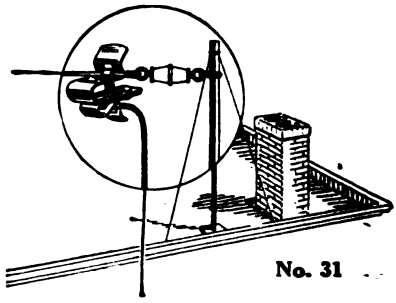
Strict adherence to these specifications in making Pacent Jacks has won for them the distinction of being used as standard equipment by many of the leading set manufacturers.

Write for catalog P-6

PACENT ELECTRIC CO., Inc.
22 Park Place ∴ ∴ New York

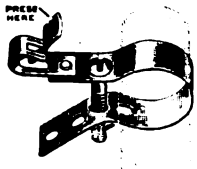
Pacent
RADIO ESSENTIALS

FAHNESTOCK'S
RADIO PRODUCTS



The Antenna Connector

Snap larger connector over Antenna Wire; insert Lead-in Wire into smaller clip and a perfect connection is the result.



Improved Ground Clamp

Equipped with Fahnestock Patent Wire Connectors Easily Attached.

No Soldering—For Radio Use Only.
Our name is stamped on all our products. None genuine without it.

At Your Dealers

FAHNESTOCK ELEC. CO.
Long Island City, New York

HEATH RADIANT CONDENSERS

A definite guarantee of lasting accuracy—PERMANENTLY FLAT Plates. The Heath process of stamping to absolute flatness and their tempering to steel hardness protects you from warping, buckling plates. The difference is worth the effort of insisting on Heath Condensers.

MICROMETER GEARED VERNIER

Reducing gear gives hair-line adjustment, so essential in the finely tuned circuits. Separate tension adjustments.

Write for Literature!

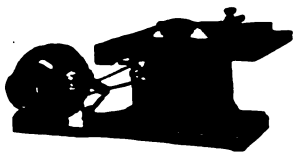
Jobbers and Dealers: Write Immediately for Proposition.

HEATH RADIO & ELEC. MFG. CO.
204 First Street Newark, N. J.

Canadian Distributor: Marconi Wireless Telegraph Co., Montreal, Canada.

Big Money Building Cabinets

With a JUNIOR BENCH SAW



People will pay you liberally for handsome cabinets to cover their Radio and you can build them easily and quickly with a Junior Bench Saw. Does your ripping, mitering, rabbeting, tenoning, sanding, grinding and many other operations with ease and accuracy. Special blades cut bakelite. Saws 1½" stock—driven by ½ h. p. motor attached to any light socket.

Sold On Absolute Money Back Guarantee
Write for descriptive folder

W. & J. BOICE, 1730 Norwood Ave., Dept. 936 Toledo, O.

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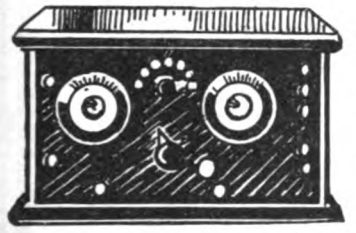
"Tune in" on Success

Learn at Home To be a Radio Expert



Radio Pays Big

The amazing expansion of Radio has opened thousands of wonderful new opportunities. Big salaries, easy and fascinating work, short hours and an excellent future are offered to ambitious men who enter the Radio field now.

Free 1000 Mile Radio Outfit

This set, when erected, has a range of over 1,000 miles. The cabinet is elegantly finished in a beautiful, lustrous mahogany. You can sell it at a handsome profit if you care to, after you have completed my course. Remember, you do not pay a single penny for it.

Membership Is Valuable!

Upon completion of my course, you receive a membership in the Radio Association of America. This designates that you are a thoroughly trained Radio man. It gives you prestige and a standing in your community not otherwise possible.

Thousands of Big Pay Opportunities

My course enables you to construct, install, operate, repair and sell Radio equipment. As my representative, you can, using either your full time or spare time, take orders from your friends and neighbors. You can easily earn from $35.00 to $125.00 a week installing Radio sets in your locality. It is being done every day by my students. What others have done, you can do.

On this very day there is someone in your neighborhood who is buying a Radio Set from someone else and is having Radio work done by others. On this very day there are big pay Radio positions that are going begging. This will be repeated tomorrow and for a long time to come. Time is precious. Begin at once to get the training that will fit you to cash in on this great chance. At least investigate. Mail the coupon to get the interesting bulletin "Radio Facts."

PROOF

Dear Mr. Mohaupt:
Your lessons are very easily digestible. To say that I enjoy them would be putting it very mildly—indeed, I crave them.
And, about the job at the Operadio Corporation; yes, I got it, thanks to you. I am learning to be an inspector at present, but I'll not stop there.
Please send me additional lessons as soon as possible.
GEO. A. GRAESSLE.

Radio Experts Earn $3,000 to $10,000 a Year

New Radio Stations are being erected every day. Thousands of corporations are putting in private stations. Every large vessel requires its Radio Staff. From everywhere comes the urgent call for Radio Trained Men. There is almost no limit to the pay. Will you step forward and grasp this brilliant money-making chance or are you going to let days drift by and let others take in the cash?

"Learn by Doing" Method

My course is not "high-brow." It is written in plain, everyday language that can be understood by any man. You need have no previous training or experience. I give you a receiving set so that I can take you thru the various steps of Radio work in a practical way. You will be delightfully astonished in having made clear to you the wonderful forces of Radio that appear so mysterious to the untrained person.

FREE

I have ready for you a copy of "Radio Facts" which tells you of the latest opportunities that exist in the great field of Radio. I want you to note my "Money Back" guarantee that protects you absolutely. I also want to tell you about the big free 1,000 mile Radio Tube Set that I give away free with my course. I urge you to act at once. Fill in your name and address on the coupon and mail it to me immediately

MAIL COUPON

A. G. Mohaupt, Radio Engr., Radio Assn. of America,
4513 Ravenswood Ave., Dept. 56, Chicago, Ill.

Please send me details of your Home Study Course—also your Free "Radio Facts" and information on how I can get a FREE 1,000 mile Radio Set.

NAME.....

ADDRESS.....

CITY.....STATE.....

A. G. MOHAUPT, Radio Engineer

RADIO ASSOCIATION of AMERICA

4513 Ravenswood Ave., Dept. 56 Chicago, Ill.

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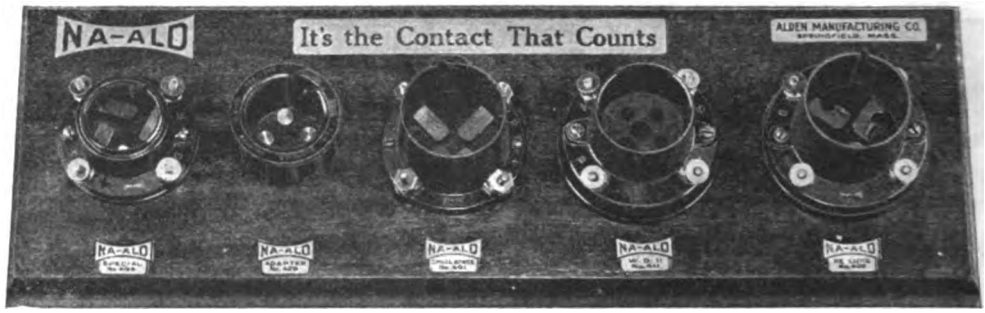

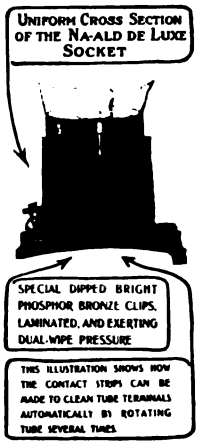
UNIFORM CROSS SECTION OF THE NA-ALD DE LUXE SOCKET
SPECIAL DIPPED BRIGHT PHOSPHOR BRONZE CLIPS, LAMINATED, AND EXERTING DUAL-WIPE PRESSURE
THIS ILLUSTRATION SHOWS HOW THE CONTACT STRIPS CAN BE MADE TO CLEAN TUBE TERMINALS AUTOMATICALLY BY ROTATING TUBE SEVERAL TIMES

Look for the socket board

In leading radio stores you will find the Na-ald Socket Board, displaying the five standard sockets included in the Na-ald line. These are; for 200 and 201 Tubes, the De Luxe at 75c and the Small Space at 35c; for the UV 199 tubes, No. 499 at 50c and an adapter at 75c; for W. D. 11 tubes, the No. 411 at 75c.

Ask your dealer to show you the self-cleaning arrangement of contacts in Na-ald De Luxe, No. 400. These dual-pressure contact strips cut into the sides of tube terminals, keeping their surface clean and bright, and resulting in perfect contact.

These sockets have the hightest dielectric properties, obtained by the thorough cure of the Bakelite used, and made possible by uniform cross-section.

There can be no noisy circuits due to poor contact with these sockets in use.

New rotogravure booklet, "What to Build," now packed with each Na-ald product. Also sent direct for 15c.

ALDEN MANUFACTURING CO. Dept. C Springfield, Mass.

NA-ALD

Smallest In Size Greatest In Results

$3.50

½ Actual Size

PREMIER Audio-Transformer Ideal for Portable Sets

Because it is the smallest, lightest, and yet unsurpassed in efficiency, the **Hegehog** is just the thing for use in portable sets where space saving, compactness, and light weight are of real importance. You take no chance with "HEGEHOG." It's a real engineering job, exclusively Premier (patents pending). A demonstrated wonder for volume, tone quality and consistent performance. Unconditionally guaranteed. Try "**Hegehog**" in your next "hook up"—portable—regular sets. Give it every possible test. If you are not satisfied in every way you can have your money back. *We know* the "HEGEHOG" and we want you to *know* it. Ratios, 1 to 3, 1 to 4, 1 to 5—$3.50. 1 to 10—$4.50. Send for free Bulletin No. 92.

ASK YOUR DEALER FOR HEGEHOG

Premier Electric Company

3807 Ravenswood Ave., CHICAGO

ELGIN *Elraco* Precision Condensers

Made by precision tool makers. Fully Guaranteed

Plates	Plain	Vernier
3	$1.75	
11	2.40	$4.00
17	2.75	
23	3.00	4.50
43	4.00	5.50

3" diameter composition dial 50c extra

See your local dealer. If he cannot supply you send his name with your order to

Elgin Radio Corporation

Radio Division of The Elgin Tool Works, Inc.

69 No. State St. ELGIN, ILL.

Perfectone Products

Loud Speaker	$15.00
Phonograph Attachment	8.75
Phones	5.00

PERFECTONE RADIO CORP.

490-C Broome St. New York

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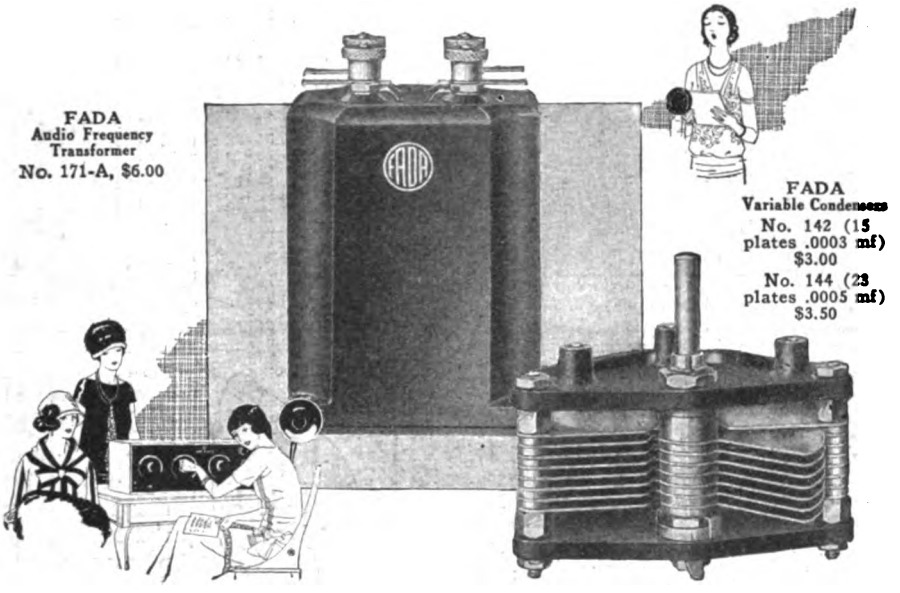
FADA

Announces a New Audio Frequency Transformer and New Variable Condensers



IN KEEPING with its established policy of producing only the finest of radio apparatus, F. A. D. Andrea, Inc., announces a new Audio Frequency Transformer suitable for all circuits and particularly adapted to the audio stages of Neutrodyne receivers.

A high average amplification over all audio frequencies is the outstanding accomplishment of this new FADA transformer. The highest note of voice or violin and the lowest note of organ or cello are reproduced with absolute tonal fidelity.

The new FADA audio transformer is a masterpiece of radio workmanship. Encased in bakelite with nickeled binding posts, it looks twice its worth. Try FADA Audio Transformers in your receiver and know what uniform and distortionless amplification really means.

—and now New Variable Condensers

The name FADA on a condenser means just one thing—condenser satisfaction. The new FADA condenser is made in two capacities 15 plate, capacity .0003 micro-farads and 23 plate, .0005 micro-farads and each the exact capacity at which it is rated. Radio frequency losses are reduced to a minimum by special rotor wiping contact brushes. A true "low-loss" condenser with an efficiency exceeding that of condensers selling at much higher prices.

Dealers are now ready to supply FADA transformers and condensers.

F. A. D. ANDREA, Inc., 1581 Jerome Avenue, New York

F. A. D. ANDREA INC. LICENSED BY INDEPENDENT RADIO MANUFACTURERS INC. NEUTRODYNE

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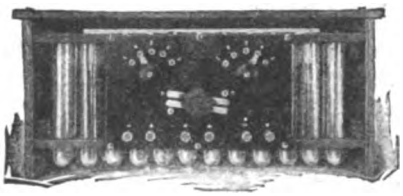
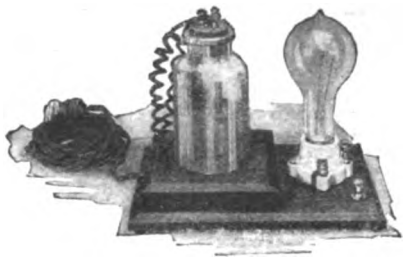


100 VOLT TYPE



KIMLEY "B" BATTERY CHARGER

A Buffalo Radio fan Gets London, England

Mr. E. C. Lewis, on March 13th, 1924, heard Mr. Marconi's voice on the model 10 Atwater Kent machine with the help of his KIC-O Battery. He said, "It would have been impossible without a KIC-O."

Try a KIC-O with your set and perhaps you can get longer ranges. KIC-O "B" batteries are of alkaline type, won't sulphate or buckle. Life unlimited. Not harmed by short circuiting, overcharging, idleness. Panel switches give single cell variations. Charge lasts from 3 to 6 months in detector plate circuit. Recharge from any 110-volt A.C. line with small home rectifier.

You are taking no chance in ordering a KIC-O as every battery is guaranteed.

Guarantee

Your money back on any KIC-O Battery if not satisfied within 30 days' trial. Write for full information on "A" and "B" Batteries.

Volts	Price, plain	With panels
22	$5.50	
32	7.25	$11.75
48	9.50	14.00
68	12.50	17.00
100	17.50	22.50
145	23.50	28.50

Unmounted Rectifier $1.00
Mounted Rectifier $2.50

KIMLEY ELECTRIC CO., Inc.

2667 Main Street :: :: Buffalo., N. Y.

Tune in the Conventions with the help of

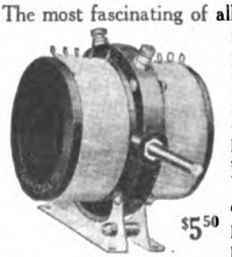
STORAGE "B" BATTERIES KIC-O

Coto

"Built First to Last"

If it's Really Portable it's Coto Compact

The most fascinating of all radio set building is preparing that portable set for your summer radio. Imagine a two tube D-X receiver on panel 5x10 inches using this moulded Variocoupler and other Coto Compact guaranteed parts.



$5.50

If your dealer does not carry Coto mail us his name and list of parts needed

COTO-COIL CO. 87 Willard Ave. Providence, R. I.

Los Angeles, 329 Union League Bldg. Minneapolis, Geo. F. Darling, 705 Plymouth Bldg. Atlanta, C. P. Atkinson, Atlanta Trust Co. Bldg. Canada, Perkins Electric Co., Ltd., Montreal, Toronto, Winnipeg

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TYPE AI
$25.00
21" Fibre Horn

The TRINITY LOUD SPEAKER

The Trinity Loud Speaker is an instrument that combines the best qualities of a phonograph reproducer in combination with electro-magnetic principles best fitted for radio amplification.

Perfect reproduction of all music and speech without distortion. No storage batteries required. The instrument is of a heavy duty type and is guaranteed fully by the manufacturers.

For sale by good dealers
Literature upon request

TRINITY RADIO CORPORATION
446½ Tremont Street, Boston, Mass.

YOU DON'T NEED TUBES

to hear programs from stations 400 to 1000 Miles Away. I can show you how to get them on YOUR CRYSTAL SET. Changes often cost Less Than One Dollar. Send self-addressed envelope for picture of my set.

LEON LAMBERT
540 So. Volutsia, Wichita, Kansas

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Final *s-c-o-r-e*

Dad may wait for the evening edition. Or grandpa for his morning paper. But when a "croocial" series is on, millions of boys, hearts thumping, eyes glistening, follow each inning, play by play, cheering as the radio brings good news, groaning when defeat threatens. As long as boys and baseball thrive in summer, so will radio.

1924 radio business is conservatively estimated at 350 million dollars. And any radio dealer can testify that the biggest and best customers of this tremendous industry are boys. Boys are the source of probably eight out of every ten sales—buying for themselves, getting dad to buy for them, or infecting their elders with radio interest and enthusiasm.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

is radio guide and authority for 500,000 boys averaging 15½ to 16 years old—leading spirits in families of very high average prosperity. Its stories and articles stimulate the radio wants of this vast army of readers. Then they eagerly read the radio advertisements.

Not only do they read the advertisements—they buy the advertised radio goods. This fact has proved itself so conclusively to radio advertisers that THE AMERICAN BOY carries, this year, more than double the radio advertising it carried in the same months last year.

Copy reaching us by June 15th will appear in August.

THE SPRAGUE PUBLISHING COMPANY

(Member A.B.C.)

548 Lafayette Boulevard **Detroit, Michigan**

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Performance plus *Beauty*

Choose your panel for its insulating value as well as for its appearance.

MAHOGANITE
Radion Panels

give you both the supreme insulation and the beauty of polished mahogany. For Mahoganite is not a surface finish but an insulating material which extends from one side of the Radion Panel to the other.

21 Stock Sizes
Mahoganite and Black

6 x 7	7 x 14	8 x 26
6 x 10½	7 x 18	9 x 14
6 x 14	7 x 21	10 x 12
6 x 21	7 x 24	12 x 14
7 x 9	7 x 26	12 x 21
7 x 10	7 x 30	14 x 18
7 x 12	7 x 48	20 x 24

RADION
The Supreme Insulation
PANELS

Look for this stamp on every genuine RADION Panel. Beware of substitutes and imitations.

At the best radio shops, or write to

American Hard Rubber Co.
11 Mercer St. New York

$200 SELECTIVITY for $8.50!

Make Every Night Silent Night!

TRAP OUT THE INTERFERENCE

Selectivity—which is merely the ability to cut out interference—is the dominating difference between the very expensive sets and the moderately priced ones. Why pay $50.00 to $200.00 extra for increased selectivity, when for $8.50 you can get a FERBEND WAVE TRAP *which will absolutely cut out any interfering station*, no matter how loud, how close by or how troublesome.

Add a Ferbend Wave Trap to Your Set

You will find it a valuable addition. It is designed and manufactured complete by us, after years of careful experimenting. It is not to be confused with imitations hastily assembled from ordinary parts. The price is $8.50. Shipment is made parcel post C. O. D. plus a few cents postage. If you prefer, you can send cash in full with order and we will ship postage prepaid. Send us your order today.

We guarantee that the Ferbend Wave Trap, when properly connected to any workable receiving set, will tune out any interfering station.

FERBEND ELECTRIC COMPANY
21 E. South Water St.
CHICAGO
Descriptive Folder on Request

FERBEND Wave Trap

Guaranteed Head-Sets

"RED-HEADS" are *guaranteed* radio phones. You run no risk when you buy them. Money back if, after 7 days' trial, you're not satisfied that they're the *best* receivers on the market at the price. Why not act *right now* and get a pair? It'll mean getting the *maximum* from broadcasting from the day you put them into use.

RED-HEAD RADIO RECEIVERS

NOW READY

The new 1924 Model F $6.50 Per Pair Complete | The new "Red-Head" Jr. $5.00 Per Pair Complete

"Red-Heads" sent prepaid on receipt of price if you are unable to get them at your dealer's.

The NEWMAN-STERN COMPANY
Dept. PR : Newman-Stern Bldg. Cleveland

LOUD SPEAKING CRYSTAL SET

Stations brought in from over 1000 miles and music heard all over the room right from your present crystal set with the STEINMETZ AMPLIFYER. Get our complete catalog.

STEINMETZ WIRELESS MFG. CO.
5703 Penn Ave., Pittsburg, Pa.

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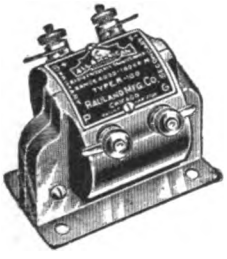
"More Applause, Please"

Express your appreciation of the programs and repay the artists for their efforts. Applaud with postals! This will encourage the best talent to go on the air more often — and add to your enjoyment of radio.

You'll want to send "Applause Cards" to them all!



The new All-American Long Wave Radio Frequency Transformer, 4,000 to 20,000 meters. Unsurpassed for Super-Heterodyne, Ultradyne and all straight r. f. and reflex circuits. $6.

DELIGHTED and thrilled by the added distance and the increased clarity and loudness of your reception, the first night you use All-American Transformers to amplify, you'll feel like writing complimentary postals to all the stations. And do it!

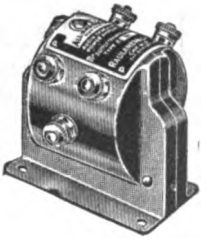
Hundreds of thousands of set-owners already know from experience how proper amplification tremendously improves the pleasure of radio. That is why All-Americans are the most popular and most widely used of all transformers.

If your reception is below par, make it "above par" with All-American Amplifying Transformers. All the better dealers sell and recommend them as the best.

Special Offer: Latest diagram-circular on Power Amplification and Book of Tested Hook-ups mailed for 4c. in stamps.

RAULAND MFG. CO., 2658 Coyne St. CHICAGO

Pioneers in the Industry



All-American Power Amplifying Transformers give amazing roundness, richness, depth and clarity of tone, as well as greater volume, when used in "push-pull" circuits. Input and Output. Each $6.

Standard on the better sets ***A type for every circuit***

ALL-AMERICAN

AMPLIFYING TRANSFORMERS

Largest Selling Transformers in the World

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Timmons Talkers

Eventually All Loud Speakers Will be in Cabinets

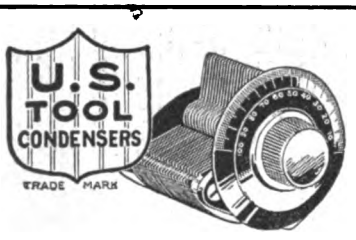
THIS is a development that is bound to come just as phonograph horns were put into cabinets. There is no sacrifice of tone because of being in a cabinet. As a matter of fact, tones from Timmons Talkers being "reflected" are pure, true and absolutely without distortion. Because of this Timmons Talkers make an especial appeal to musicians.

This "reflecting" of tones is accomplished by using two horns—one facing the other—and is similar in principle to the strings and sounding board of your piano.

We'll be glad to send you a cut-away view showing all the details of Timmons Talkers, including "Reflected Tone." Our folder, "Volume Without Noise," will be sent at the same time.

J. S. TIMMONS

339 E. Tulpehocken St., Germantown, Phila., Pa.



Up to the

Progress of Radio

Material and workmanship equal to the most exacting requirements of the latest circuits.

For Use Superheterodyne, Superdyne, Inverse Duplex, Four Circuit Tuner Vernier Cap. .00057 Mfd. (24 Plate) or Plain Cap. .00055 Mfd. (23 Plate)

Condensers of recommended capacity for all known circuits are also carried in stock by leading radio retailers.

End Plates of CELORON

Be Sure of Quality, Buy U. S. Tool Condensers

100% Guaranteed!

Write for Booklet

U. S. TOOL CO., Inc.

116 Mechanic St. Newark, N. J.

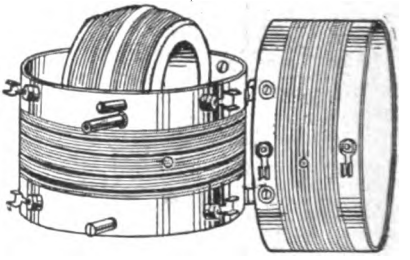
100% EFFICIENCY

guaranteed in using the

EASTERN COUPLER

for the

Superdyne Circuit



Most improved design and finest workmanship. Wound with double silk wire on Genuine Bakelite Tubing.
Picture hook-up and material list free with each coupler.

PRICE, $6.00

Mail orders filled. Dealers communicate.

EASTERN COIL CORPORATION

22 Warren St., Dept. P. R., New York, N.Y.

CRESCENT LAVITE RESISTANCES

12,000
45,000
50,000
100,000
Ohms.

LIST $1.50

Special Sizes to Order

Used in the New Cockaday Circuit. Dealers write for discount.
CRESCENT RADIO SUPPLY CO. 1-3-5 Liberty St., Jamaica, N. Y.

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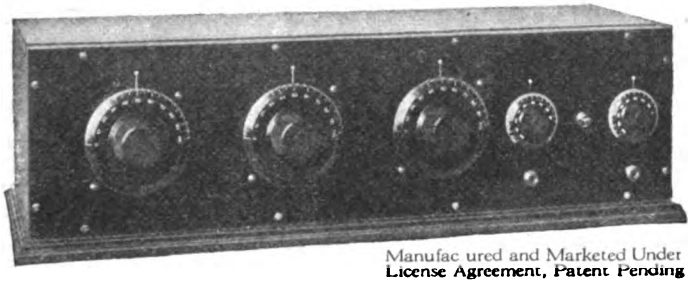
Pathé

"MINUTE MAN"

Radio Receiving Set

incorporating

Pathé Type "P" Phusiformers



Manufac ured and Marketed Under License Agreement, Patent Pending

Price $125.00
(tubes, batteries extra)

THE new five-tube "Minute Man" was specially constructed to meet the demand for a receiving set embodying these features:

NO SQUEALS

Tune in either with a loud speaker or head phones without any squeals or rasping. At any setting of the dials there is none of the unpleasantness so prominent in many other sets.

PURE TONE

The reproduction of broadcasting by the "Minute Man" is remarkable for its clarity and sweetness of tone, increasing your enjoyment a hundredfold.

SIMPLICITY

The "Minute Man" is simplicity itself to operate. The dials can be adjusted by a child — and the set is "fool-proof." The dial settings are constant. A station once located can always be brought in without preliminary searching.

Free Booklet
Booklet "How to Build a 5-Tube Receiver, Using Three Phusiformers," sent free on request. Address Dept. A19.

Genuine mahogany cabinet and panels. Gold engraved dials.

PATHÉ PHONOGRAPH & RADIO CORP.
20 GRAND AVENUE :: BROOKLYN, N. Y.

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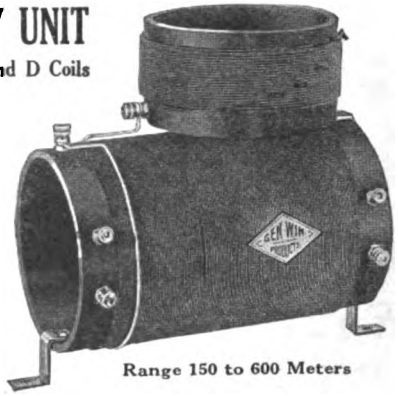
GEN-WIN TRADE MARK PRODUCTS

COCKADAY UNIT

Full Set A, B, C and D Coils

Made strictly in accordance to Mr. Cockaday's Specifications



Range 150 to 600 Meters

For 1, 3 and 5 Tube Set

Price $5.50

Best quality Radion hard rubber tubing ½" wall wound with No. 18 double silk covered wire.

Three Large Blue Prints, Illustrated Instructions, and Material Lists for Building the 1, 3 and 5 Tube Cockaday Sets

Price 50c

(Free with order for unit)

A set is no better than its weakest part. If your Coil is of inferior material or workmanship, you cannot expect to get good results. Thousands of GEN-WIN Coil users write us constantly, telling of the wonderful results they are procuring. If your Coil is unsatisfactory, replace it with a GEN-WIN and see the difference.

Guaranteed mechanically and electrically perfect. The outstanding features: Complete set of A, B, C and D Coils with beautifully knurled binding posts, eliminating loose end wires, insuring perfect contact and easier wiring. Made of the best quality material combined with expert workmanship. Distributed capacity or leakage and dielectric losses practically eliminated. Insures selectivity with maximum sensitivity and volume.

Unconditionally Guaranteed to Give Absolute Satisfaction

At Your Dealer, Otherwise Shipped to You Postpaid

GENERAL RADIO WINDING CO. 214 FULTON ST. NEW YORK, N.Y.

RATHBUN

SINGLE-HOLE MOUNTING

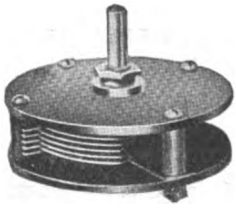
SUPERIOR CONDENSERS

Special—13 Plate

NEUTRODYNE

CONDENSERS

GIVE that absolutely precise control of capacities which is the whole secret of a successful neutrodyne receiver. Plates maintained ***lastingly*** aligned: stator plates anchored in accurately milled tubes and rotor plates revolving smoothly on hard, non-wearing bearings that permit no variation at any point. Single hole mounting prevents any possible torsion in mounting. No iron or steel to produce magnetic fields. ***Rathbun Neutrodyne Condensers*** make enough difference to be worth insisting upon ***no substitution.***



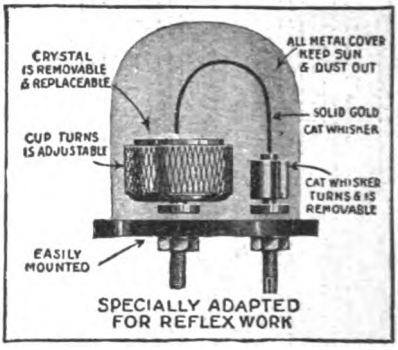
Capacity .0003 MFD

LIST $3.00

Write TODAY for the name of the nearest Rathbun dealer and for illustrated literature.

Rathbun Mfg. Co. Inc.
Jamestown, N. Y.

"Kills Reflex Troubles"


CRYSTAL IS REMOVABLE & REPLACEABLE
ALL METAL COVER KEEP SUN & DUST OUT
SOLID GOLD CAT WHISKER
CUP TURNS IS ADJUSTABLE
CAT WHISKER TURNS & IS REMOVABLE
EASILY MOUNTED
SPECIALLY ADAPTED FOR REFLEX WORK

"LINCOLN" DETECTOR

Creating tremendous sensation. Enclosed, fixed, adjustable. New. Brings in distant stations loud and clear. You need it. Price only $2.00. Absolutely guaranteed for one year.

Jobbers, Dealers: Write or Write. Mention this ad.

LINCOLN MFG. CO., Dept. J-1 Los Angeles, Calif.

RADIODYNE

NO LOOPS—NO AERIAL

Ready for operation by grounding to a water pipe or radiator, and throwing a few feet of wire on the floor. Uses any standard tubes—dry cell or storage battery. Extremely selective. Simple to operate—*only two controls.* Wavelength from 200 to 700 meters. Write for Folder describing this (antennaless) receiver.

WESTERN COIL & E. CO.
314 Fifth Street Racine, Wis.

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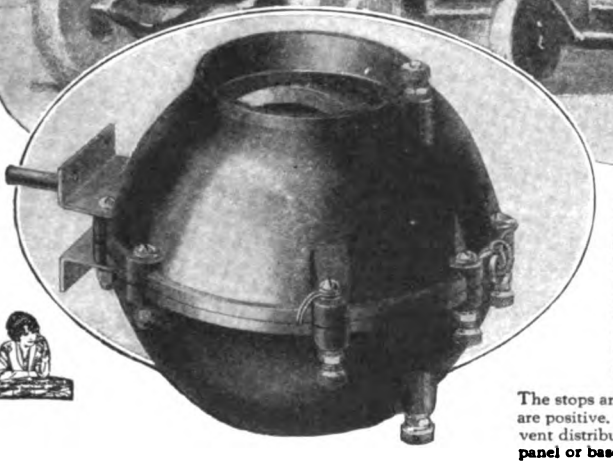
PULLING POWER



Heavy Bakelite shells of rich brown color. Windings of correct gauge wire and properly proportioned for best reception. Large bearings assure smooth operation and long life. No sliding contacts; rotor connections made with special flexible wires, through hollow shaft to binding posts on stator shell.

The stops are a part of the stator and rotor and are positive. Bakelite especially treated to prevent distributed capacity. Arranged for either **panel or base mounting.**

VOLUME!

THE variometor or variocoupler is responsible for the strength of the signals received. Therefore, the size, shape, gauge of wire and number of turns in the Kellogg variometers and variocouplers are the result of exhaustive tests for equipment that will give the best radio reception.

Therefore, it is to your advantage to demand Kellogg variometers and variocouplers and know that you will receive better reception, resulting in maximum entertainment, and value from your radio set.

If your dealer does not handle Kellogg, communicate direct with us.

KELLOGG SWITCHBOARD & SUPPLY CO.

1066 West Adams Street, Chicago

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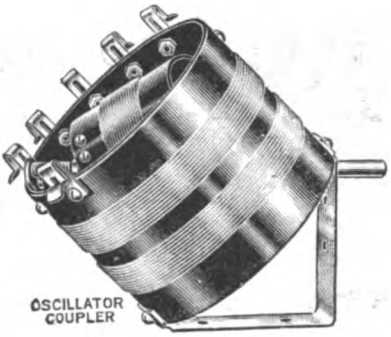
SUPER HETERODYNE PARTS



NEW YORK COIL, 3,000 Meter R K TYPE, INTERMEDIATE FREQUENCY TRANS-FORMERS are marvels of efficiency. Scientific positioning of primary and secondary, together with their extreme low height—1¼"—allows shorter grid and plate, wire connections than found in any other manufactured.

Price $4.00

OSCILLATOR COUPLER, Large XX Bakelite Black Tubing, Size 3¾ x 3", using low resistance double silk wire. Rotor, 180 degree type, 6 Fahnestock terminals, metal parts all nickeled. Will improve any heterodyne set. Price $4.00.

NEW YORK Condenser Tuned Radio Frequency Trans-Formers are designed to operate in *popular present-day circuits*. Electrical losses, such as distributed capacity have been reduced to the minimum.

NEW YORK COIL CO.

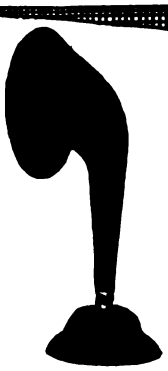
The transformer is rigidly secured to our universally known New York Variable Condenser of 17 plates, which will tune sharply all wave lengths from 250 to 575 meters. ***Price, including Condenser, $4.50.***

NEW YORK COIL CO., 338 Pearl Street, New York

Pacific Coast—MARSHANK SALES CO., 1240 S. Main St., Los Angeles, Cal.

$8.00

14" - - - $12.50



The fact that the Fibertone is used by more Loud Speaker Manufacturers than any other one horn is a significant endorsement to those who want the best reproduction for the least investment. The base is designed to fit the phone from any head set. Use your own unit which you know is good.

If your dealer cannot supply you, write to us direct.

FIBER PRODUCTS COMPANY
34 Orange St. Bloomfield, N. J.

FIBERTONE
RADIO HORN

CARTER PORTABLE JACK

$1.50

Just the thing for summer. Keep the set in the house and extend the loud speaker out on the porch. Also for camping—touring and summer cottage use. Takes any standard Plug. Can be connected to set by wires to binding posts, or jack.

Any dealer can supply

Carter Radio Co.
1807 REPUBLIC BUILDING
CHICAGO

VACUUM TUBES REPAIRED

WD-11, WD12, UV-201A, UV-199, And others for $2.50

Quick service. All tubes repaired by us guaranteed to work as good as new.
Send your dead tubes. All you pay is $2.50 plus Postage to Postman.

THOMAS BROWN CO.
511-519 Orange St. Newark, N. J.

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For the Fullest Measure

of Undistorted Volume

TO obtain the fullest measure of undistorted volume, your receiver must deliver to the diaphragm of your loudspeaker or ear phones audio frequencies which will produce the maximum volume and purest qualities of tone.

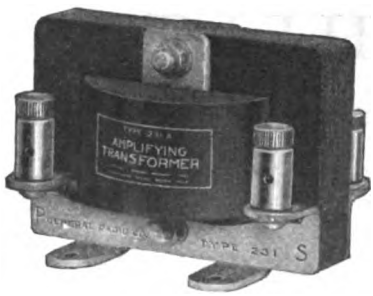
This depends directly upon the efficiency of your audio amplifying transformers.

The GENERAL RADIO CO. type 231-A is distinctly a quality transformer — of high electrical and mechanical efficiency.

Features contributing to its superior performance are:

Low loss steel used in its core construction.
Layer winding properly insulated and impregnated.
Air gaps in core to avoid distortion.
Unbreakable feet with convenient mounting holes.
Heavy leads with soldered connections.
High and flat amplification curve Which indicates that amplification is nearly uniform throughout its entire audio range, making it best for all stages.

Turns ratio 3.7 to 1 **Impedance ratio 10 to 1**



TYPE 231-A
Amplifying Transformer
"Best for All Stages"
PRICE $5.00

Sold by Good Radio Dealers EVERYWHERE

GENERAL RADIO COMPANY
Manufacturers of
Electrical and Radio Laboratory Apparatus
Massachusetts Ave. and Windsor St.
CAMBRIDGE, MASS.

"Products of Proven Merit"

GENERAL RADIO Co

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A $200,000.00 COMPANY STANDS SQUARELY BACK of EVERY PHONE

TOWER'S Scientific

WEIGHS ONLY 8 OZ

Perfect Tone Mates

$2.95

Plus a few cents postage

SEND NO MONEY

Order by mail if your dealer cannot supply you and we will ship immediately. Written 5-day money back Guarantee with each set.

Our next year's production schedule of two million phones UNDOUBTEDLY places us as the

WORLDS LARGEST HEADSET MAKERS

THE TOWER MFG. CO.

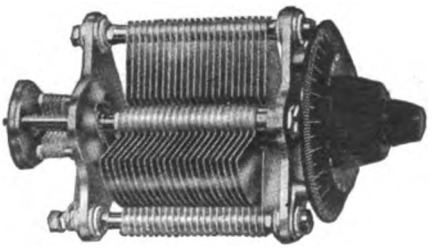
J98 BROOKLINE AVE. BOSTON MASS.

WORLDS GREATEST HEADSET VALUE

Five-Day Money-Back Guarantee If Not Fully Satisfied. We Guarantee the Scientific to be

1. One of the finest phones on the market regardless of price.
2. The most comfortable—weight only 8 oz.
3. Perfect tone mates.
4. Made of standard double pole construction (no single pole nonsense to save expense.)
5. Made of the best materials money can buy. Powerful magnets, genuine tinsel cords, aluminum cases.
6. Manufactured under ideal working conditions.

CHELTEN



Special Condensers
have these special features

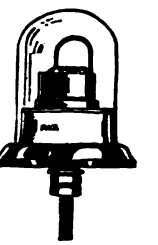
1. Lowest Dielectric Losses
2. Special porcelain insulation used on stator Plates.
3. Copper Pigtail Connections
4. Aluminum End Plates
5. Rotor Plates of heavy aluminum
6. Accurate spacing
7. Adjustable accurate bearings
8. Permanent Stops
9. 9-Plate Vernier makes possible sharp close tuning
10. Vernier has same special insulating features.

With and without Special 9-plate Vernier

CHELTEN ELECTRIC CO.
4861 Stenton Ave. Philadelphia

Grewol *Fixed Reflex* Detector

Its adjustment, made permanent at the factory, makes it best for the Reflex Circuit. Immune to jarring, dust and dampness.

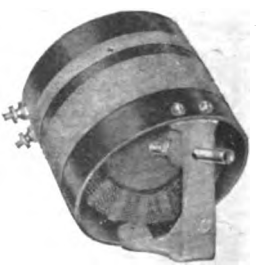


NEW LIST PRICE **$1.50**

At Your Dealer's Or Direct

GREWOL MFG. CO.
Newark, N. J.

SIMPLEX



180° D-X Tuner

Volume=D-X=Selectivity

Especially designed for the 3 circuit, untuned primary circuit. No solution is used to hold the windings in place, thus a much more efficient winding results. Excellent for D-X and extremely selective with wonderful clear volume. Very simple to install and operate.

Price $3.50

SIMPLEX RADIO CO.
1013-15 Ridge Ave. Phila., Pa.

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The Crosley Two Tube Marvel

THOUSANDS of homes have been made happy by this little Crosley Model 51. In twenty-four days from its first appearance it was selling at the rate of 1,000 per day and hundreds of letters expressing appreciation of its excellent performance assured us that it was a favorite.

One of its two tubes is the noted Armstrong regenerative detector with the hook-up made popular in the Crosley Type V. Added to this is one tube of Audio Frequency Amplification giving Loud Speaker volume on local stations at all times and on different stations under fair receiving conditions. Otherwise head phones should be used for distant reception.

This Crosley two tube marvel has been a surprise to the Radio World and has proven the biggest seller on the market to-day. Have you bought yours? If not see your dealer to-day.

Other Crosley Models

Practically every Radio Dealer can furnish you Crosley Radio sets including not only the Model 51 but the Type V, a single tube receiver at $16.00, the Model VI at $24.00; the Super VI at $29.00; the Model X-J at $55.00; the Super X-J at $65.00 and the Trirdyn at $65.00. etc. The Crosley line is so complete that every home can find just the receiver to suit their desires or their limitations.

Send for Complete Crosley Catalog

Crosley produces more Radio Receiver Sets than any other manufacturer in the world.

CROSLEY
Better-Cost Less
Radio Products

Crosley regenerator receivers are licensed under Armstrong U. S. Patent No. 1,113,149.

The Crosley Radio Corporation

Powel Crosley, Jr., President
Formerly
The Precision Equipment Company and Crosley Manufacturing Company
616 Alfred Street **Cincinnati, Ohio**

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"The only loud speaker that can hold my receiving set is the

THOROPHONE

TRADE MARK REG. U.S. PAT. OFFICE

—*says* WM. G. SMITH

High Power Model S-5 **$45.00**

POWER that makes other loud speakers jump off the table merely makes the Thorophone produce greater volume. The Thorophone will take all you can give it and still reproduce voice and music so naturally that you'd think speaker or musician were right in the room.

Until you have heard the Thorophone you have not learned how wonderful radio is. Whatever your receiving set, the Thorophone will make it sound better. It reproduces perfectly. The controlled mica diaphragm; the scientifically designed Thorite horn; the additional power from the 6-volt storage battery—these things make the Thorophone the ultimate loud speaker.

For endless satisfaction, buy the Thorophone.

Write for Booklet

WINKLER-REICHMANN CO.
4801 S. Morgan St., Chicago, Ill.

ARROW BATTERY SLASHES Prices TO CONSUMERS ONLY

Prices Smashed!
Quality Not Sacrificed

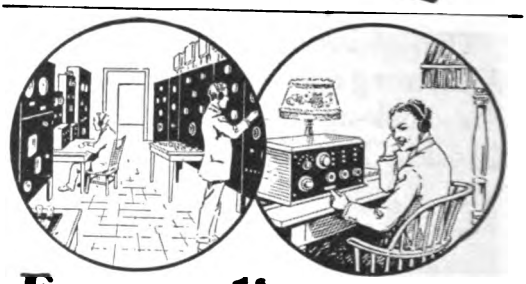
Here is real battery quality, guaranteed to you, at prices that will astound the entire battery-buying public. Order direct from factory. Put the Dealer's Profit in your own pocket. You actually save much more than half, and so that you can be convinced of true quality and performance, we give a **Written Two-Year Guarantee**

Here is your protection! No need to take a chance. Our battery is right—and the price is the lowest ever made. Convince yourself. Read the prices!

Special 2-Volt Radio Storage Battery,	$2.75
Special 4-Volt Radio Storage Battery,	6.00
6-Volt, 60 Amp. Radio Storage Battery,	7.00
6-Volt, 80 Amp. Radio Storage Battery,	8.00
6-Volt, 100 Amp. Radio Storage Battery,	9.50
6-Volt, 120 Amp. Radio Storage Battery,	11.50
6-Volt, 140 Amp. Radio Storage Battery,	13.00

We ask for no deposit. Simply send name and address and style wanted. Battery will be shipped the day we receive your order Express C. O. D., subject to your examination on arrival. Our guarantee accompanies each battery. We allow 5% discount for cash in full with order. You cannot lose! Act quick. Send your order today—NOW.

Arrow Battery Co.
1421 South Wabash Ave.
Dept. 7 Chicago, Ill.



For sending or receiving—

Bakelite-Dilecto Panels are FAULTLESS

Panels of this excellent material are giving perfect service in many of the greatest broadcasting stations. And in thousands of homes it is making possible the highest achievements in radio reception, through its many valuable, radio-advantageous qualities.

bakelite-dilecto

(A Laminated Phenolic Condensation Material)

The U. S. Navy and Signal Corps have used Bakelite-Dilecto for nearly ten years. To knowing radio men, that is plenty of proof of the product's merit. Panel *your* radio set with Bakelite-Dilecto. Your dealer can get it cut and drilled for you.

THE CONTINENTAL FIBRE CO.
Factory: Newark, Delaware

Service on Bakelite-Dilecto (also Continental-Bakelite, Conite, Contex and Vulcanized Fibre) from:

New York, Woolworth Bldg. Chicago, Wrigley Bldg.
Pittsburgh, 301 Fifth Ave. San Francisco, 75 Fremont St.
Los Angeles, 307 S. Hill St. Seattle, 1041 Sixth Ave., So.

Offices and Agents Throughout the World

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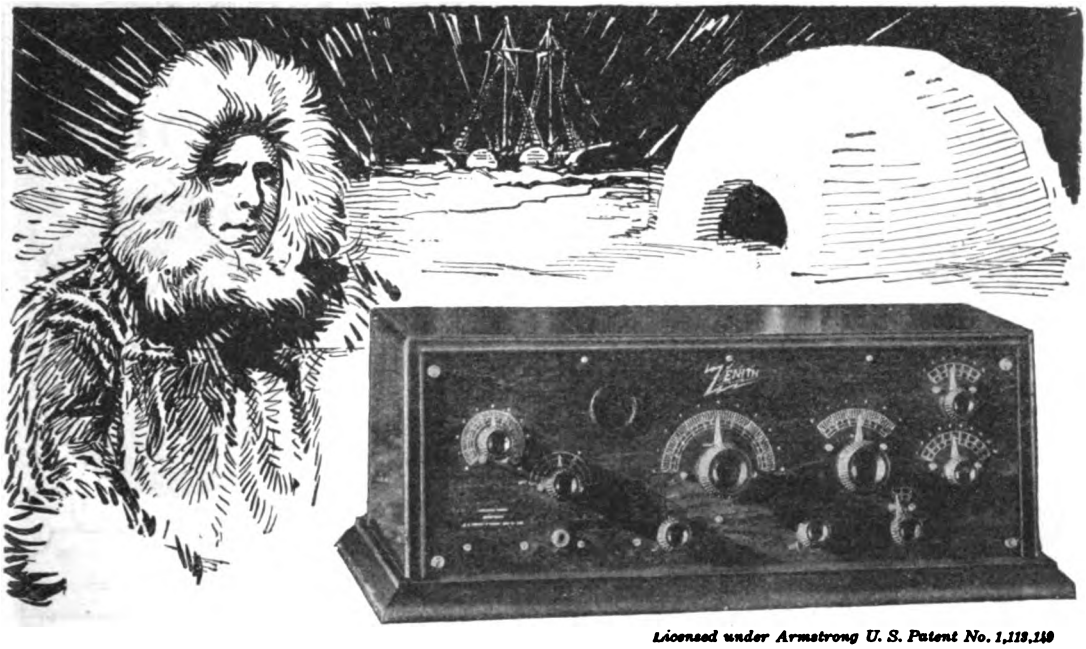

Licensed under Armstrong U. S. Patent No. 1,113,149

MacMillan Listens to Honolulu and New Zealand "Tunes In" California using ZENITH Long-Distance Radio

From a little ice-bound schooner—eleven degrees from the North Pole—comes this message:

"Am very thankful that Arctic Exploring Ship Bowdoin is equipped with complete Zenith radio apparatus. Here at top of world, in darkness of great Arctic night, we have already listened to stations practically all over the United States, from Europe, and even from far away Honolulu. Zenith has united the ends of the earth.—MacMillan."

Again, from far-off New Zealand comes a report of radio reception even more startling:

"It may interest you to know that the writer last evening landed KGO, Oakland, California, between 6:45 and 7:30 P. M. Heard his call four or five times distinctly, and jazz music. As San Francisco is ***6,300 miles from New Plymouth,*** and only one tube was used, we think this is a very fair performance."
—(signed) H. Charles Collier.

The sets used by Captain MacMillan and Mr. Collier are earlier models—since improved by the addition of ***a third stage of audio frequency.*** These new models represent an achievement not duplicated in any other set on the market. Write today for full particulars and name of nearest dealer.

Zenith Radio Corporation

McCORMICK BUILDING, CHICAGO, ILLINOIS

Model 3R The new Zenith 3R "Long-Distance" Receiver-Amplifier combines a specially designed distortionless three-stage amplifier with the new and different Zenith three-circuit regenerative tuner.

Fine vernier adjustments—in connection with the unique Zenith aperiodic or non-resonant "selector" primary circuit—make possible extreme selectivity.

2,000 to 3,000 Miles With Any Loud-Speaker

With the new Zenith 3R satisfactory reception over distances of 2,000 to 3,000 miles, and over, is often accomplished in full volume, using ***any ordinary loud-speaker.*** The Model 3R is compact, graceful in line, and built in a highly finished mahogany cabinet - - - - **$160**

Model 4R The new Zenith 4R "Long-Distance" Receiver-Amplifier comprises a complete three-circuit regenerative receiver of the feed-back type. It employs the new Zenith regenerative circuit in combination with an ***audion detector*** and ***three-stage*** audio-frequency amplifier, all in one cabinet.

The Zenith 4R may be connected directly to any loud-speaker ***without*** the use of other amplification for full phonograph volume, and reception may be satisfactorily accomplished over distances of more than 2,000 miles **$85**

ZENITH RADIO CORPORATION,
Dept. 1-E 328 South Michigan Avenue, Chicago, Illinois
Gentlemen:
Please send me illustrated literature on Zenith Radio.

Name .....

Address .....

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STANDARD of EXCELLENCE

for audio amplification

This summer you will be able to enjoy radio as never before.

AMERTRAN

TRADE MARK REG. U.S. PAT. OFF.

Improve your set with an AmerTran

Now made in two types:

AmerTran Type AF-6, (Turn ratio 5)—long acknowledged the high measure of achievement in audio transformer design.

AmerTran Type AF-7, (Turn ratio 3½)—a companion transformer for use in second or third stages of sets provided with powerful regenerative or radio frequency amplification, and when AF-6 is used in the first stage.

These two types are the results of continuous study and experiment since the days when we furnished the Marconi Company with transformers for the first commercial trans-atlantic wireless communication.

Price, either type, $7
At your dealers.

Send for Circular

American Transformer Company

Designers and builders of radio transformers for over 23 years

175 Emmet Street **Newark, N. J.**

Why miss Stations?

TUNE THEM IN WITH

The "EZTOON"

Station wave lengths are so close together that unless you can tune extremely close you lose all of them.

Super Heterodyne owners put one on your heterodyne and oscillator condensers. Tuning will have a new meaning.

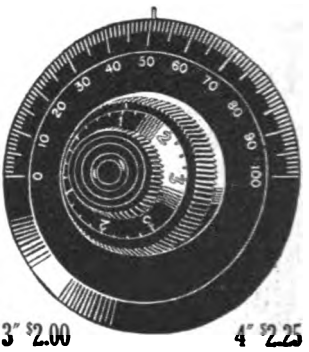
On Neutrodyne using three "Ezytones" gives unbelievable results.

No drilling; take off present dial and slip on "Ezytone." Done in a second.

Sold under positive money back guarantee.

Ask your dealer. If he cannot supply we will ship parcel post, prepaid.

Jobbers, Manufacturers, write for discounts.



3" $2.00 4" $2.25

Two dials in 40 to 1 ratio.
Has no cog gears.
No back lash and turns as smooth as glass.
Gives Vernier adjustment to Variocouplers, Variometers, Condensers, Potentiometers, Rheostats, etc.

BUTLER MANUFACTURING CO.

3236 W. Washington St., **Indianapolis, Ind.**

Complete Parts for the BREMER-TULLY "Nameless" R. F. Circuit

are now available in "Kit" Form.

KIT No. 1 —includes Vernier Condensers and Rheostats, 3-Circuit and Audio Transformers; Jacks, drilled and engraved panel, sub-base, etc. (everything for 5-tube set except Tubes, Cabinet and phones)—all parts of every highest grade manufacture.

Price $63.50

KIT No. 2 —essential B-T parts for 5-tube set.
3—.0005 Vernier Condensers
3—3 circuit Transformers
2—3 plate Condensers
1—set diagrams, etc.

Price $26.50

Diagrams furnished with above show complete diagrams and instructions for building on the now famous "Step-by-step" plan.

Order from your dealer

Bremer-Tully Mfg. Co.

534 S. Canal St. **Chicago, Ill.**

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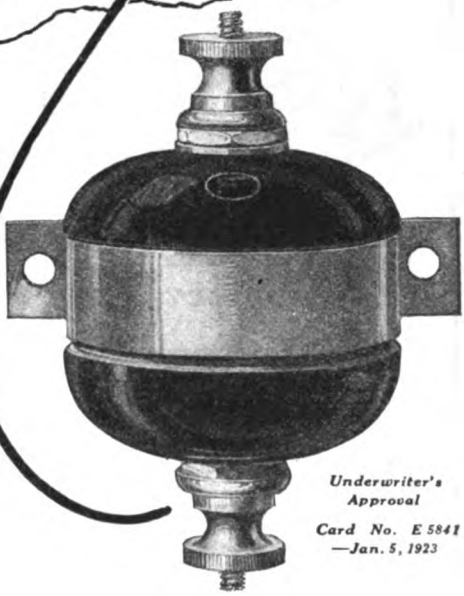
UNDERWRITERS' REQUIREMENTS

"Each lead-in wire shall be provided with an approved protective device properly connected and located (inside or outside the building) as near as practical to the point where the wire enters the building.

. . . . . The protective device shall be an APPROVED LIGHTNING ARRESTER which will operate at a potential of 500 volts or less."

-here it is!

not only *approved* by the Underwriters, but by thousands of radio enthusiasts, who are using it and who **pronounce it *real protection***



Underwriter's Approval

Card No. E 5841 —Jan. 5, 1923

No. 248

"Little Joe" *Lightning Arrester*

The illustration shows "Little Joe"—a compact little unit but a giant in performance of the work for which it was designed. ... a heavy porcelain body beautifully glazed in a brown tone. So designed that it will interfere in no way with the radio receiving set. And it can either be suspended upon the aerial or fastened to wall with the heavy brass clamp which is furnished with each "Little Joe."

The Lightning Arrester Season Is Now On

Endangering thunder storms are upon us. Insurance inspectors are critical in their examination of home outfits. All radio users should have lightning arresters to conform with the above rulings.

"Little Joe" is your one best bet. Supplied through your Dealer.

GUARANTEED F WIRING DEVICES

E. H. FREEMAN ELECTRIC CO., Trenton, N. J.

Manufacturers of "Circle F" Wiring Devices

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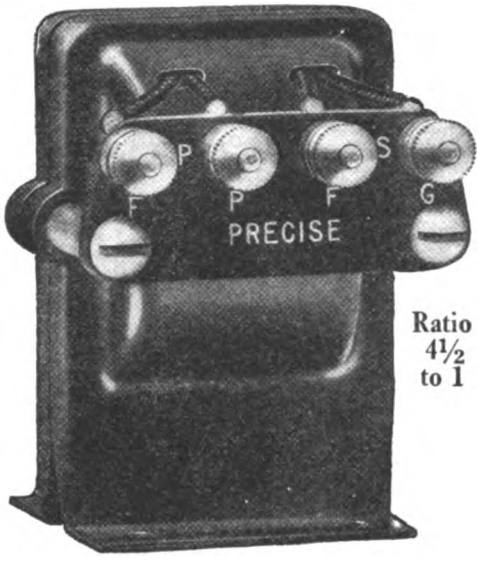


Ratio
4½
to 1

PRECISE $5.00 Transformer

Guaranteed better than any other at any price or money refunded

IN every test made to date the Precise has demonstrated its superiority.

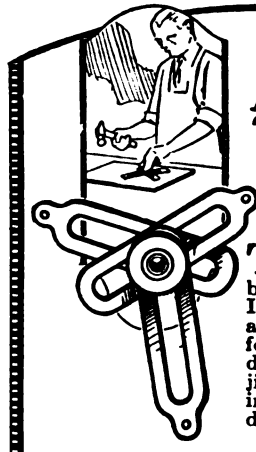
Perfect tonal value and rendition from the deep vibrant basso to the high notes of the violin.

30 Days' Trial

Try a Precise Transformer on your own set. If your dealer cannot supply you, order one direct. It will be sent, postpaid, on receipt of price. If you are not satisfied, return within thirty days and we will refund your money.

Precise Manufacturing Corporation
Rochester, N. Y.

Branches: 53 W. Jackson Blvd., Chicago, Ill.; 821 Market St., San Francisco, Cal. Eastern Sales Office: Niagara Sales Corp., 3-5 Waverly Place, New York City. Canadian Distributors, Perkins Electric, Ltd., Toronto, Montreal and Winnipeg



The Church AUTOMATIC TEMPLATE

Just three taps— AND YOU'RE READY TO DRILL ACCURATELY

THE Church AUTOMATIC TEMPLATE belongs in your tool kit! It is a device that will accurately locate the holes for anything from a condenser to a switch—in a jiffy. It absolutely eliminates the need for rulers, dividers, or scribers.

The Church AUTOMATIC TEMPLATE has myriads of uses about the home, the garage, or the shop. It is, for instance, the only tool that will find the center of a screwhole.

$1 LIST

GET ONE TODAY

(If your dealer cannot supply you, write us. Room 609)

NATIONAL DISTRIBUTORS
CLARK & TILSON Inc
1 East 42 Street N.Y.C.

No More Cabinets

JUST APPLY FLAT MAHOGANY OR PLATE GLASS COVERS TO THE NEW

Quinby Radio Frames

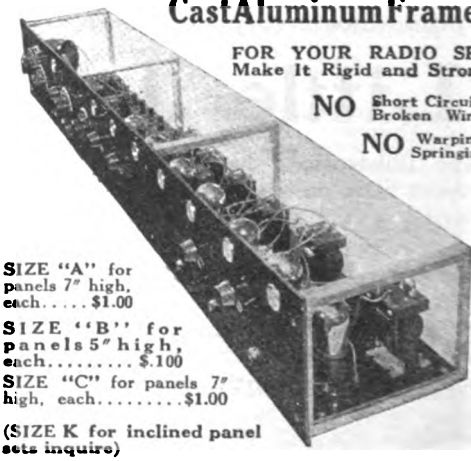
(PATENT APPLIED FOR)

"It's a Frame Up"
Cast Aluminum Frames

FOR YOUR RADIO SET
Make It Rigid and Strong

NO Short Circuits Broken Wires

NO Warping Springing



SIZE "A" for panels 7" high, each.....$1.00

SIZE "B" for panels 5" high, each.....$.100

SIZE "C" for panels 7" high, each.....$1.00

(SIZE K for inclined panel sets inquire)

QUINBY RADIO FRAME CORP.
Subway Building
587 West 181st Street :: New York

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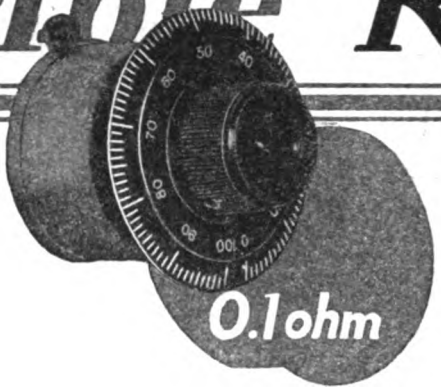
Triple Range



Low Loss

The True Measure of Efficiency

0.1 ohm is the resistance of the

CONNECTICUT

D-10

Triple Range Variable Condenser

at a capacity of 330 micro-microfarads on a wave length of 215 meters.

This is a statement that means something.

Those who know that the losses of a condenser are in direct proportion to its resistance—

Those who have learned that measurements taken at radio frequency are much more valuable than those taken at audio frequency—

Those who can see the importance of judging the efficiency of a condenser for amateur and broadcast work on results obtained at a frequency in the immediate vicinity of that at which it is to be used—

Will see in the above the real reason why this condenser should be used by all who wish to obtain the greatest degree of signal strength and sensitivity from their receiving equipment.

Three Condensers in One

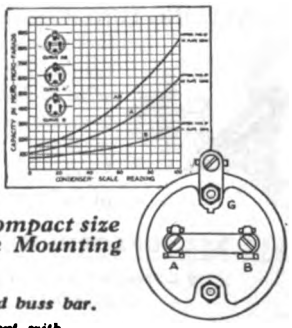
These three ranges of capacity enable it to take the place of the ordinary eleven, twenty-three and forty-three plate instruments.

The chart tells the story—

The range indicated by Curve B—from .000075 to .000275 mfd.—approximately that of an eleven plate condenser, is secured by wiring into the circuit from posts G and B.

The range indicated by Curve A—from .0001 to .0006 mfd.—approximately that of a twenty-three plate condenser, is secured by wiring into the circuit from posts G and A.

The range indicated by Curve AB—from .00015 to .00085—approximately that of a forty-three plate condenser is secured by bussing A and B and wiring into the circuit from G and B.



FEATURES: Vernier Scale—Complete Shielding—Compact size And all the convenience that goes with One-hole Mounting

PRICE $4.50

Complete with dial, index stud, spacing washers and buss bar.

Send for Bulletin A-104 describing this unique instrument, with information and diagrams illustrating its special applications.

CONNECTICUT TELEPHONE & ELECTRIC COMPANY
MERIDEN RADIO DIVISION CONNECTICUT

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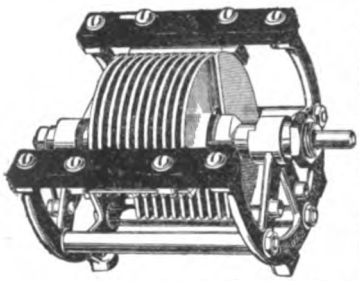
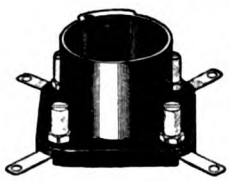
BUELL
E. J. Flewelling
RADIO APPARATUS

It's the Distance That Counts—

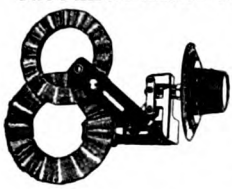


Link your set with the far away stations—CYB, KGW, WDAP, WGY, WMC, WOAI and the many others you have failed to tune in. Miles mean very little to a capably built set. But no set can be at its best without FLEWELLING CONDENSERS! It is this master constructed condenser that will solve your problem of distance without the sacrifice of selectivity, tone and clarity. Install FLEWELLING CONDENSERS in your set tonight. Or better still—build a new set around FLEWELLING parts. The twenty-three plate size (.0005 mfd.) is now available. Price . . **$7.00**



Many *so-called tube noises* vanish when FLEWELLING SOCKETS are brought into use. Short, direct contacts of the improved "side-wiping" design, attribute much to the efficiency of performance. Price . . **$1.00**

The FLEWELLING TUNER requires but little cabinet space and produces big results. The coils are free of solid dielectrics and are interchangeable. However, an extremely wide range may be covered with but one set of coils. Price . . **$8.00**



BUELL MANUFACTURING COMPANY
2979 Cottage Grove Avenue
CHICAGO

Regal

"Pays for Itself in Longer Service"

Perfect Contact Vernier Rheostat

For fine filament control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market.

Complete with Knob

6-Ohms.....**$1.25**
30-Ohms.....**1.25**

Fifteen Taps—But Only One Drill Hole Required!

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of holes. No more chipped panels. Complete with hard rubber Knob and Dial.

Type No. 162.....**$1.50**

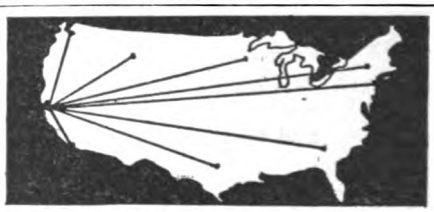
Broadcast Tested High Quality Audio Transformer

For clearness of tone, amplification of voice and music from nearby and distant broadcasting stations, Regals are unequaled by any Transformers on the market.

3½ to 1 Ratio.....**$4.25**
5 to 1 Ratio.....**4.50**

At all good dealers—otherwise write direct for complete descriptive folder No. 24, sending dealer's name.

AMERICAN SPECIALTY CO.
Bridgeport, Connecticut, U. S. A.



ON ONE TUBE

Broadcasting from Atlantic Coast, Canada, Mexico, Cuba & Hawaii heard in Calif. by users of the CROSS COUNTRY CIRCUIT. Range due to simplicity. One tuning control. ANY NOVICE can build easily and cheaply. Dry cell tubes used. No soldering. Complete instructions, Blue print panel layout, Assembly Photo, etc., postpaid 25 cents. Stamps accepted.

VESCO RADIO CO., Box PR-117, OAKLAND, CALIF.

B-METAL

Wilkinsburg, Pa., 3-21-24
Gentlemen:
Kindly quote me your price per dozen on your B-metal Loud Talking 50c Crystals. I now have one of these Crystals in use in a reflex circuit, and the longer it is used, the better results are obtained.
Yours truly
(signed) C. B. LAMBERSON
B-Metal Refining Co. 7th Floor 525 Woodward Ave., Detroit, Mich.

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The New Melco Supreme Kit!

THE Melco Supreme Kit is ready for you! Follow the detailed blue prints and book of instructions and you can build at much less than regular cost the popular Melco Supreme. Melco is accepted as the greatest and most consistent long distance receiver available. It is supersensitive — has extreme selectivity — is exceptionally clear and tunes with the greatest of ease! Own a Melco Supreme — build it with the Melco Supreme Kit!

Write for Complete Literature on Parts and Sets

Kit Contains:

1—Telos Variometer
1—Telos Vario-Transformer, 1st stage
1—Telos Vario-Transformer, 2nd stage
3—4" Amsco "Vernigrip" Bakelite Dials
2—Amsco Compensating Condensers
1—By-pass .5 mfd. Condenser
1—Grid Leak and Holder
1—Antenna Series Condenser
1—.005 mfd. Condenser
1—.00025 mfd. Condenser
1—100 Ohm Tube Protective Resistance
Blue Prints and Book of Instructions

Every instrument laboratory tested and unqualifiedly guaranteed

AMSCO PRODUCTS, INC.
Broome and Lafayette Sts., New York, N. Y.

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S PRESS
TIMBRETONE LOUD SPEAKER
CAUSES STIR IN RADIO FIELD
Design, Construction and Tone Qualities Place
Timbretone in Class by Itself---Genius Designed
It, Master Craftsmen Build It---Huge Demand
Predicted---A Hoosick Falls Product from Start
to Finish.

(Made in Hoosick Falls, N. Y., by the Timbretone Mfg. Co.)

THE immediate response to our advertisement of last month prompts us to make a last minute change in this copy.

Orders received from all parts of the country have simply swamped us and we ask your indulgence in the shipping of your order in its turn.

We hope this condition will not arise again and find us wanting.

Those who have heard TIMBRETONE are unstinting in their praise. There is a treat in store for those who have not. Go to your dealer and ask him to order one for you. If either he or you are dissatisfied return it to us and your money will be refunded. If no dealer is available write us direct.

It is all wood—the older it grows the better it gets.

Retails at $20.00

How to Get the Best Results from Your Radio Set

First of all, remember that *good panels* are absolutely necessary — because the greater the volume and surface resistivity of the panels, the less surface-leakage and power-loss in your set.

Also remember that to get the best results you should use a new, *sharp* drill with *slight* pressure.

There is no longer any incentive to buy inferior panels, for the best panels made—

ELECTRASOTE
REG. U.S PAT OFF
TRADE MARK

RADIO PANELS

can be bought at any good Radio Dealer's Store

At 25 to 50% Less

than any other standard panel

Electrasote is one of the "Sote" products of world-wide fame introduced by THE PANTASOTE CO., INC.

All Standard Sizes

JOBBERS AND DEALERS: Write for our interesting proposition.

M. M. FLERON & SON, INC.
Exclusive Sales Agents for Electrasote Radio Panels
Trenton, New Jersey

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Announcing:—

A New Magnavox M4

requiring no battery

THE supreme achievement of Magnavox engineers represented in a Reproducer of truly *exquisite* tone quality.

The superb tone quality of M4 results from the perfection of the Magnavox semi-dynamic operating principle incorporating; *first*, a new magnetically balanced armature; *second*, an improved type of diaphragm supported by hollow rubber gaskets; and *third*, an extremely high resistance winding which makes M4 unusually sensitive.

Price $25.00

Beautifully finished in dark enamel with gold high lighting.

Equipped with flexible cord and Weston plug ready to connect as simply as a head set.

Magnavox M4 and other Magnavox Radio Products can be had of good dealers everywhere

THE MAGNAVOX CO., OAKLAND, CALIF.
New York Office: 351 West 31st Street
***Canadian Distributors:* Perkins Electric Limited, Toronto, Montreal, Winnipeg**

MAGNAVOX
The Reproducer Supreme

6R

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ATWATER KENT

Philadelphia

Exceptional Radio Performance

THE outstanding preference, among families the nation over, for the ATWATER KENT Receiving Set is due to its remarkable performance—to its exceptional selectivity, its wide range—volume of clear reception and ease of operation.

The tonal fidelity of the ATWATER KENT Loud Speaker is the delight of every owner.

ATWATER KENT MFG. CO.
4933 STENTON AVE.,
PHILA., PA.

A Loop Antenna—Properly Designed

Will tune over the Broadcasting wave-range of 190 to 600 meters with a 23-plate condenser connected across its terminals.

THE CALVERT LOOP

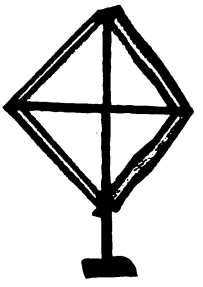
helps to make reception of signals and concerts a certainty.

Low Resistance

Low Capacity

Directional

Presents a fine appearance and is perfectly constructed, both mechanically and electrically.



Electric Constants

Distributed Capacity .....22 μμf.
True Inductance.....242 μh.
Natural Period.....2142 kc.

List Price.....$10.00

For further information write to

CALVERT SPECIALTY CO., Inc.
1310 Callowhill St., Philadelphia, Pa.

PREMIER "Microstat"
TRADE MARK

Super-Vernier RHEOSTAT

In a class by itself

MICROSTAT really does what you thought yours would do. Gives Micro Vernier filament control instantaneously. ***Handles any tube of any battery.*** Capacity 3 amp. Does not get noisy. Stays put. The real essentials of a 100% rheostat. Designed and built for those who know quality. You will ultimately come to the **Microstat**. Its principal of operation is new. Two windings in parallel. One 6 ohms—other 40 ohms on which we effect our Vernier control. Absolutely noiseless. A smooth, positive action. Bakelite moulded base. Silver etched dial. A real job. Install a **Microstat** in your next; "hook-up." You'll discover the reason why **Microstat** makes poor sets function well. Send for Free Bulletin No. 92.

Ask your dealer for Microstat

Premier Electric Company
3807 Ravenswood Ave., Chicago

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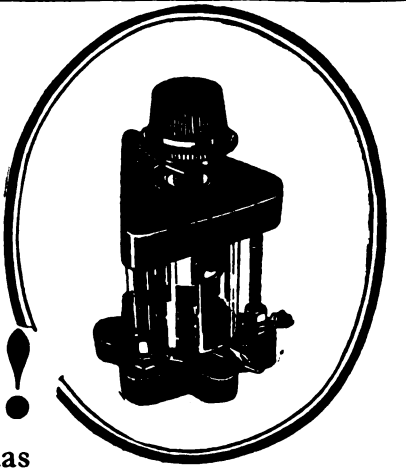
Reflex Problem SOLVED!



AT last the experimenter who has searched for the ideal crystal can depend upon a perfect detector. The New Freshman Double-Adjustable Crystal Detector has met every requirement of the ideal unit. It affords uninterrupted, noiseless, distortionless reception, yielding extraordinary volume with entire absence of squeals and howls often introduced by vacuum tube detectors.

Note These Exclusive Features:

1. Turns the crystal without disturbing the contact pressure.
2. Non-metallic housing prevents short-circuiting noises during adjustment!
3. Mounts neatly on the panel with only small knob showing!
4. Contact cannot be jarred from sensitive spot!
5. Adjustable at panel, also at base, with tension adjustment additional!
6. Super-Crystal withstands high voltages!
7. Loop-end contact permits complete coverage of crystal with gliding movement!
8. Rigid construction!

Hundreds of enthusiastic users of the new Freshman Detector are proclaiming it by far the best detector ever offered. Manufacturers of Reflex receivers, tuned radio frequency, "Supers," and similar circuits are specifying Freshman's for their crystal detectors. More for your money than in any detector ever offered!

What one Editor said of the Freshman Crystal

"The new Freshman 'double-adjustable' crystal detector 'stayed put,' even when the set was deliberately shaken, stood up to 130 volts on the plate circuit without noise or distortion," *wrote editor of New York Evening World's Radio Magazine in an article of March 19th, 1924. And in a review he continued:* "This detector meets every requirement of the reflex circuit.

"It is enclosed and provided with two adjustments, one varying the position of the crystal, and the other regulating the brush contact adjustment.

"The crystal is a pure natural ore and is embedded in an insulated housing, thus eliminating short circuits and consequent loud noises resulting from the cat whisker touching the metal housing.

"The Freshman detector can be panel mounted with only a small knob showing. All around it is the best crystal detector unit found for reflex work."

FRESHMAN

Double-Adjustable Crystal Detector
For base or panel use, complete with super crystal

Freshman Super Crystal With Non-Metallic Housing **50c**

$1.50

No more searching for the sensitive spot—merely turn the knob as you would a dial!

FREE—Write for building plan of New York Times Reflex. Gives panel layout, list of parts required, etc. Operates loud speaker on two tubes. Ask for circular C-102.

Chas. Freshman Co. Inc.
Radio Condenser Products
106 Seventh Avenue, New York City

Other Freshman products include variable grid leaks, fixed mica condensers, variable condensers, Antenellas, resistances, by-pass condensers, etc. At your dealer's, or, send purchase price and you will be supplied postpaid.

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—An Amazing Value in Long Distance Radio Sets

The popularity of MIRACO radio sets is reflected in our tremendous volume and the hundreds of unsolicited testimonials that come to us day after day from our thousands of satisfied users.

The MIRACO is so popular because it is priced at a ridiculously low figure for a real quality set. Just think, only $29.50 for the model shown in the illustration above and users tell us that they have gotten as many as 122 stations in three consecutive nights and many of them over 2000 miles away. For instance, Mr. E. D. Elliott of Milford, New York, got London, England, Fairbanks, Alaska, La Palma, Panama, San Francisco, Los Angeles, Hood River, Oregon and many others within several evenings. Others have done equally as well.

Everyone can now own a Quality Radio Set

These two improved MIRACO models make it possible for every family to own a set—to have a box seat for the opera or symphony or jazz concert right in their own living room.

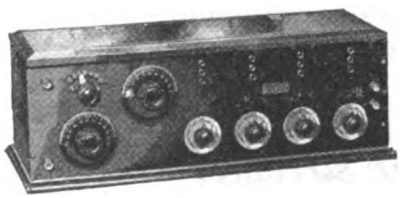
Workmanship is unexcelled—easy and simple to operate—always dependable. Solid mahogany cabinet—fully guaranteed against any defects in workmanship.

Price for { **2-TUBE SET—$29.50**
4-TUBE SET—$54.50

WRITE FOR OUR NEW BULLETIN TODAY

DEALERS — AGENTS

There's still some territory open. Write or wire for proposition



MIDWEST RADIO COMPANY
812 Main Street **Cincinnati, Ohio**

How to buy transformers

In selecting these important elements, your inspection should plow beneath a pleasing finish. Besides turn ratios, you should know that wire sizes and impedances are correct for the tubes to be used.

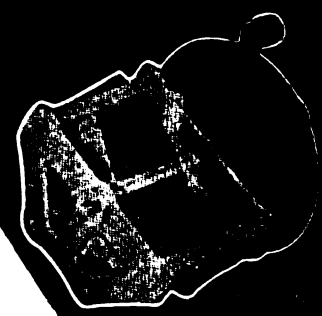
New folder—free

This gives you details for a complete line of transformers—uniform in appearance, and uniform in the high quality of results obtained.

A post card in the next mail will bring your copy quickly

RUBICON COMPANY
918 Victory Bldg.
Philadelphia

DUPLEX



Series "FR" Condenser

Designed to ground the rotor to frame. Electrically and mechanically perfect.

We have reduced the electrical losses to an immeasurable minimum.

Some profitable jobber territory still open.

Write for Bulletin "Facts for Fans" on Condensers

The DUPLEX ENGINE GOVERNOR CO., Inc
50 Flatbush Ave. Extension
BROOKLYN, N. Y.

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Establishing

The MOZART Baby GRAND

IT was only to be expected that our name would help toward establishing our new reproducer in the enviable position it is so rapidly gaining.

Whatever the reason, probably no similar product ever met with more instantaneous success. May we quote from another entirely unsolicited appreciation, which accompanied one of our most recent repeat orders.

"All who have heard it have told me to keep it in the background, as I still have ..... to get rid of. For clearness, it is the best I have heard and I feel I cannot stock too many.
Ship C.O.D., etc."
(Signed) C. Kreslog, Wabash, Indiana.

PRICES—F. O. B. Factory

Reproducer complete with (gold plated) unit and polarity-indicating cord	**$12.00**
Unit only with polarity-indicating cord, gold plated	**5.00**
Unit only with polarity-indicating cord, nickel plated	**4.00**

Shipping weight of reproducer, 7 lbs. (approx.).
Dimensions—diameter of bell 12 inches. Length and height overall, 12½ inches.

Orders sent direct should be accompanied with a local dealer's name when possible.

Radio Division

The MOZART-GRAND CO.

Manufacturers of Fine Instruments

Newark, N. J. U. S. A.

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SE-AR-DE

QUALITY

Radio Frequency Air Coil Transformers

Three Units in a Box with Two Compensating Condensers Price **$22.50**

MOST EFFICIENT

Designed for use in Tuned Radio Frequency Circuits

Ideal Tuning Elements for Several of the "Dyne" Type of Sets

The Coils are Mounted on Our No. 111 11 Plate Condensers

Cover Wave Lengths Between 230 and 580 Meters

R. MITCHELL CO.

255 Atlantic Ave. Boston, Mass.

Representatives

A. R. Morton . . . . 395 Broadway, New York City
Globe-Commercial Co., 709 Mission St., San Francisco

South America

A. H. Kelleher . . 44 Whitehall St., New York City

The Van-Le Reproducer

An entirely new and radical departure in the amplification of sound waves.
Throaty tones eliminated. Sound waves carry equally to any portion of the room.

Ask your dealer or write us

Dealers write for our special proposition

VAN-LE CORPORATION

100 Sip Avenue, Jersey City, New Jersey.

The perfect radio switch—correctly designed and skillfully constructed. Installed on any panel in five minutes to add hours of convenience, and protect both tubes and batteries. At dealers everywhere—insist on the genuine—in the orange and blue box. If your dealer has not been stocked send 60c plus 10c for packing and you will be supplied direct.

THE CUTLER-HAMMER MFG. CO.
Member Radio Section
Associated Manufacturers of Electrical Supplies
Milwaukee, Wisconsin

RADIO SWITCH

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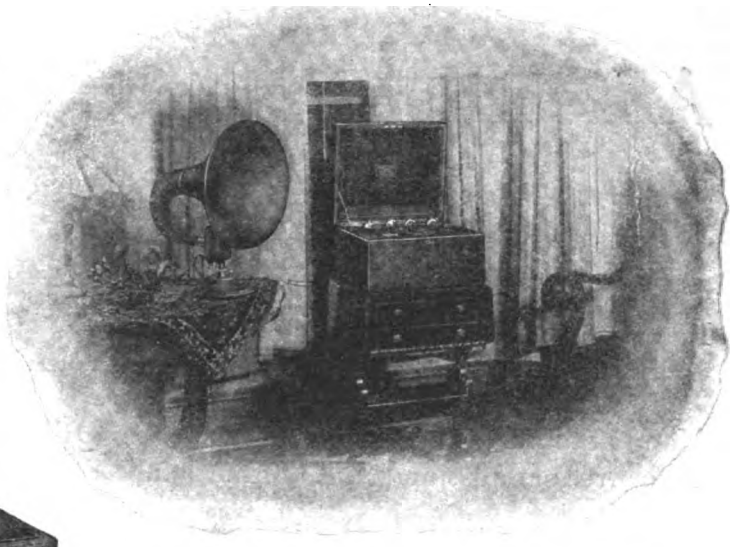
Bristol Single Control Radio Receiving Set together with Bristol Senior Audiophone Loud Speaker as used in One of the Finer Homes.



Radio Reception Simplified to Single Control Dial

It is an easy matter for any member of the family to operate a set like this. A good illustration of the absolute simplicity of

BRISTOL SINGLE CONTROL RADIO RECEIVER

Using Grimes Inverse Duplex System
(Patents Pending)

is the fact that a set is installed in the home of a blind woman who operates it herself and is able to bring in station after station at her will.

Powerful enough to get long distance reception. It is a four-tube set using Grimes Inverse Duplex System, which makes it equal to six tubes because the first two tubes are utilized for both Radio and Audio Amplification.

Non Reradiating—will not disturb your neighbors' reception when you tune in.

Many refinements, including panel with telephone jacks on back of the case for making connections.

Used with Aerial or Loop, and in some locations short Inside Antenna will give good results. When Aerial and Loop are both provided it is only necessary to operate a lever to change from one to the other.

The case is solid mahogany finish with walnut stain. It is handsome in appearance, and at the same time provides a rugged protection for the working parts.

Price of Bristol Single Control Radio Receiver without accessories $190.00.

BRISTOL AUDIOPHONE LOUD SPEAKERS

made in three models, Senior $30.00, Junior $22.50, Baby $12.50.

The most recent development in these models is the fibre horn with which the Baby Audiophone is now furnished, as illustrated below.

Write for Bulletin No. 3013-L

MADE AND SOLD BY

THE BRISTOL COMPANY

Waterbury, Conn.

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Specify

A Leather Covered Radio Set

Because—Experts found that *leather* is the only material that will withstand wear and hard usage.

Because—it reflects quality.

Because—it costs no more than imitations.

We are manufacturers of all grades of cowhide grains.

Manufacturers—You will need leather for PORTABLE SETS. Write us for free samples and full information.

Eagle-Ottawa Leather Co.

74 Gold St.
New York City

226 West Lake St.
Chicago, Illinois

"The Best Built Set in America" R-212

RADIO SERVICE LABORATORIES

Licensed by I. R. M., Inc., under Hazeltine Patents

Embodying the Hazeltine Neutrodyne circuit in an improved form as to neutralization, workmanship, quality, appearance and efficiency of operation.

Radio Service Laboratories, 1000 11th Ave.
Asbury Park, N. J.

RADIO CATALOGUE

Sent upon receipt of 10c which will be credited on the first order of over $1.00.

Write

HAROLD HERBERT Inc.
160 W. 46th St., N. Y. C.

EISEMANN RADIO EQUIPMENT

comprises

Headsets, Variometers, Variocouplers, Condensers, Potentiometers, Detector, Resistance-Adapter, Radio and Audio Amplifier Units, A.F. Amplifying Transformer, and ready drilled metal panels.

Also, the new R F-2 Broadcast Receiver.

Write for Prices and Descriptive Literature

EISEMANN

EISEMANN MAGNETO CORPORATION
165 Broadway, New York
Detroit Chicago San Francisco

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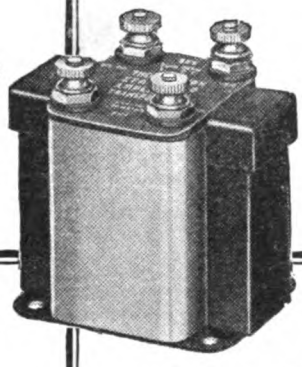
THE PERFECT REPRODUCER

3½-1 = Ratio
$4.00

6-1 = Ratio
$4.50



SUPER TRANSFORMER
(AUDIO FREQUENCY)

Did you ever realize that the small reproducer which rides the record is the most vital part of your phonograph? The most elaborate phonograph made with a poor reproducer would be worthless as a musical instrument.

The reproducer of your radio set is your amplifying transformer.

The Thordarson Super Transformer was designed and built with one primal aim,—perfect reproduction. It is the result of the combined efforts of Thordarson engineers and nationally known tone experts and musicians.

Thordarson amplification provides the finishing touch of refinement for your receiver—"that breath of life," you have so long sought.

THORDARSON THREE STAGE AMPLIFICATION USED BY KENNEDY AND ZENITH

For a year both of these manufacturers have used the Thordarson Super Transformer exclusively in both their two stage and three stage amplifiers. That's irrefutable proof of Thordarson excellence. These transformers are so well constructed electrically, and so completely shielded, that they can be placed side by side, even in a three stage amplifier, and still be free from distortion and howling.

Even Amplification Over the Entire Musical Range

THORDARSON
ELECTRIC MFG. CO.
CHICAGO, ILLINOIS

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"Take No Chances—Use Como"

COMO DUPLEX

The World's Standard Push Pull Transformer

PRICE $12.50 per pair

For maximum volume without distortion

Como Tuned Intermediate Frequency Transformer—30 Kilocycle

PRICE $6.00

For use as input or output transformer in Super-heterodyne circuits

What Prominent Writers on Radio Subjects say About Como.

Lewis B. Hagerman, Technical Editor, *Chicago Post:* "Actual Tests show this transformer to be far superior to any others of similar makes."

R. J. Robbins, *New York Sun:* "After consideration of several well-known makes of push pull transformers which are available "COMO DUPLEX" was selected as most satisfactory."

C. White, *Radio World:* "COMO DUPLEX" is infinitely superior—most other push pull transformers seem to be ordinary transformers with a center tap brought out as a makeshift."

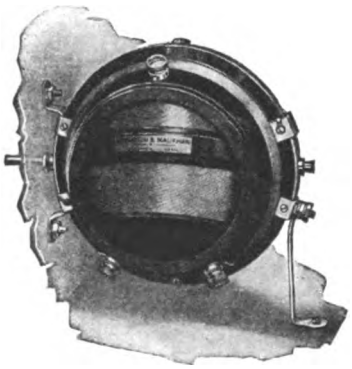
E. P. Gordon, *Open Road:* "A system of audio-amplification which is becoming increasingly popular. Its use.....will give surprising results in both quality and volume, and is thoroughly recommended by this department."

NEED WE SAY MORE?

COMO APPARATUS COMPANY

446 TREMONT ST. ∴ ∴ BOSTON, MASS.

For Sale at Leading Dealers



Amplify with

LANGBEIN & KAUFMAN TUNED RADIO FREQUENCY VARIOTRANSFORMERS

TYPE VT25 LIST $8.50

Connected same as a fixed radio-frequency transformer, but continuously adjustable to the peak of the wave.

MAXIMUM AMPLIFICATION AT ALL WAVE LENGTHS

SEND FOR DIAGRAM % 101

THE HOME OF MOULDED TUNER SPECIALTIES

LANGBEIN & KAUFMAN
654 Grand Avenue
NEW HAVEN CONN.

If You Build Your Own

Super-Heterodyne

you will find that it is necessary to get the right Grid Leak Value

YOU NEED TWO

FRESHMAN

VARIABLE GRID LEAKS

with .00025 Mfd. Condenser combined **$1.00**

FREE! Write for complete Super-Heterodyne wiring diagram showing all connections and parts required. Ask for circular L-I.

Freshman variable grid leak is the most compact, most efficient, most adaptable to all grid circuits, and, being entirely sealed, is unaffected by any climatic changes.

Chas. Freshman Co. Inc.
Radio Condenser Products
106 Seventh Ave., New York City

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Eagle Neutrodyne Balanced! RADIO RECEIVER

EVERYWHERE the EAGLE leads! Fine balance of tube capacities—perfect as the balance of the experienced structural iron worker. Quality, the sum total of infinite skill and years of experience. Until **others can successfully duplicate the exceptional skill in balancing and testing of each receiver, there can be no real rival of the EAGLE. A product of "quality" rather than quantity production. Stations located instantly by turning dials *always* to the same points.**

Easy to operate as a phonograph

Unreservedly guaranteed.

Write for Literature

Licensed by Independent Radio Manufacturers, Inc., under Hazeltine Patent No. 1,450,080, dated March 27th, 1923, and other patents pending.

WE SOAR ABOVE
EAGLE RADIO COMPANY
NEWARK NEW JERSEY

18 Boyden Place

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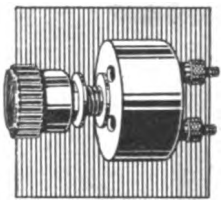
More energy will *reach* your *phones* when you stop the *little* energy *leaks*

THE major units of your equipment—the transformers, tuning units, tubes and batteries—can function at their best, *only* when your *smaller* parts also deliver "Leak-Proof" service.

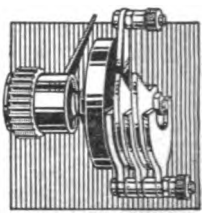
If sockets and grid leaks, jacks and plugs, switches and other accessories drain energy away, your larger instruments fail to deliver to your phones, the volume and distance you ought to get!

Make your expensive instruments give full value! Select small accessories whose design and quality insures "leak-proof" service!

Specify "MAR-CO" when you buy small parts—you'll save energy right from the start, and you'll save money in the long run.



Probably nowhere else can you accomplish so much for $1.50, as by investing it in the even, step-less, *super-critical* grid control of the new MAR-CO variable grid leak.



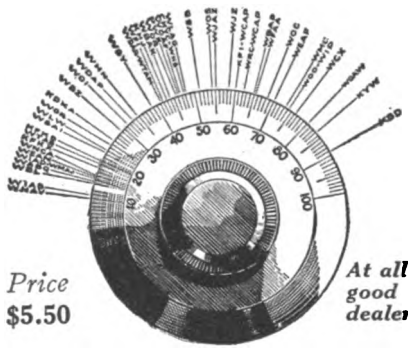
When you can't quite tell whether you've got it or not, then the new MAR-CO super-vernier condenser lends the *added* sharpness that *gets* the exceptional station! $1.25

MAR-CO

RADIO PRODUCTS

PLUGS · JACKS · RHEOSTATS · SOCKETS · SWITCHES · NEUTRALIZING CONDENSERS

8½ HOURS
ON THE AIR
With Two Tubes



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UNCLE SAM MASTER TUNING COIL
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This is a calibration of a set submitted to a committee of engineers in Philadelphia. Remember, the same stations will be heard at the same points on the condenser night after night. Ask your dealer or send us self addressed stamped envelope for wiring diagram and panel layout of this set.

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Voceleste
(VOICE FROM THE SKY)

Wherever you go; touring, yachting, camping, take all the delights of high class radio with you. The New Portable Voceleste is a self-contained, 6-tube set with internal batteries and folding loop, completely housed in beautiful black grained luggage case, 10 by 14 by 18 inches and weighing only 30 pounds with batteries. A set of great range, splendid tone and **remarkable selective qualities.** Voceleste rotating loop, mounted on bracket, folds instantly and stows in case. Sweet toned loud speaker is part of set.

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RADIO-REPRODUCTION LOUD SPEAKER

"The Musician of the Air"

Presidential Conventions

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A Message to the Public!

THE very next best thing to being actually present at these two events, of national and international importance, is to **hear their** ATLAS Re-PRODUCTION. Bring these momentous proceedings and orations right into your home in all their original naturalness for the entertainment and instruction of your family and friends. Get *all* of these speeches, every word clearly inflected, in the full, undistorted tones of the speaker. Just as realistic as though you were actually there. Buy your *Atlas* NOW!

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THE Burgess Radio "A" is exclusively a radio battery, designed especially for service on the "A" or filament circuit of dry cell vacuum tubes.

In Radio service it has over twice the life of the ordinary No. 6 ignition battery . . . costs approximately the same . . . has a rapid recovery to high voltage after short periods of rest . . . practically no voltage is lost when not in use.

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"ASK ANY RADIO ENGINEER"

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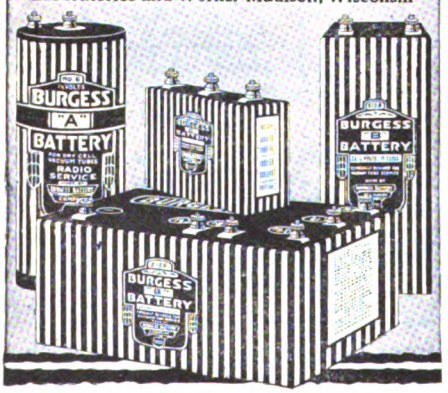
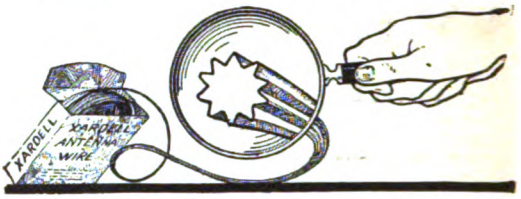


DX-10-POINT



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Designed for long distance reception and is different and better than the usual make-shifts, being hard drawn from the finest copper, having a corrugated surface with ten collecting points on the circumference. This gives a greater collective surface to the high frequency radio currents. The result is extreme sensitiveness and increase in range and clearness of any set from the simplest Crystal to the finest multiple tube receiver.

Use this antenna wire and enjoy the full possibilities of your set.

Sold in coils 100 feet, 200 feet and 500 feet. Order direct or from your nearest dealer.

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An indestructible all-metal quality product with a worth-while guarantee. Endorsed by the Tribune Institute.

Accepted as the logical solution to radio soldering problems.

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Handle always cool

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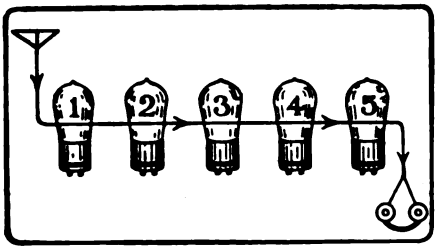
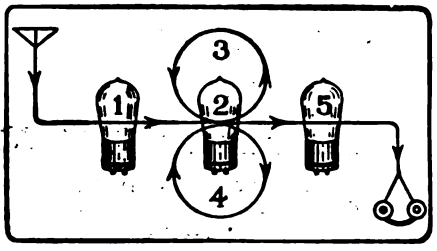
Why Use Five Tubes

To Do the Work of Three?

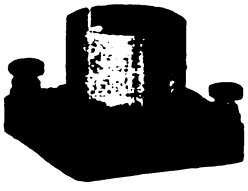


Three tubes, duo-reflexed as shown at the right, are fully equal to five tubes in conventional sequence.



The most important advance in coupling methods of late years is Erla Selectoformer, materially improving range, selectivity and volume. $5

Erla Push-Pull transformers handle output of five-watt power tubes, using as high as 350 volts on the plate, without distortion. Pair $10



Exclusive, double, tilting springs of Erla Sockets give clean, wiping contact essential to low amperage tubes. List 65c and 75c

FIVE stages of amplification with only three tubes—this is the secret of the amazing coast-to-coast loud speaker range of the Erla three-tube Duo-Reflex circuit, surpassing all but the most elaborate hook-ups in volume.

Erla Duo-Reflex action (patent applied for) enables vacuum tubes to do triple duty, as simultaneous amplifiers of received radio, reflexed radio and reflexed audio currents, multiplying efficiency while reducing cost.

Indispensable to the practical application of this principle, and the foundation of its success, are Erla synchronizing transformers.

Accurately superimposing (1) received and reflexed radio, and (2) rectified radio and reflexed audio currents, in their coincident passage through amplifying tubes, they eliminate all trace of distortion. Only those who have actually heard Erla performance can realize the vast improvement in tone quality resulting.

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Erla Selectoformer, tested capacity condensers, and fixed crystal rectifier spell outstanding advancement in their respective fields.

For complete Erla circuits, ask your dealer for Bulletin No. 20; or write, giving his name.

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ERLA

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MALONE-LEMMON PRODUCTS
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Putting **QUALITY** *into* **RADIO**

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Super-Sensitive Amplifying TRANSFORMERS

Mail this coupon and get your copy of our latest bulletin, "Putting Quality into Radio."

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STATEMENT OF THE OWNERSHIP, MANAGEMENT CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF POPULAR RADIO
Published monthly at New York, N. Y., for April 1, 1924.

STATE OF NEW YORK } ss.
COUNTY OF NEW YORK }

Before me, a Notary in and for the State and county aforesaid, personally appeared Douglas H. Cooke, who, having been duly sworn according to law, deposes and says that he is the Business Manager of POPULAR RADIO, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, POPULAR RADIO, Inc., 627 West 43rd Street, New York; Editor, Kendall Banning, 627 West 43rd Street, New York; Managing Editor, Katrine A. Campbell, 627 West 43rd Street, New York; Business Manager, Douglas H. Cooke, 627 West 43rd Street, New York. 2. That the owner is: POPULAR RADIO, Inc., whose stockholders are: New Fiction Publishing Corporation, 627 West 43rd Street, New York City, whose stockholders are: Douglas H. Cooke, 627 West 43rd Street, New York City; George d'Utassy, 465 East 57th Street, New York City, Vernal W. Bates, 46 George Street, New Haven, Conn.; Wiley Blair, 4607 Ross Avenue, Dallas, Texas; Harold B. Emerson, 9 East 40th Street, New York City; William Green, 627 West 43rd Street, New York City; *Harris Corporation, 34 Pine Street, New York City; Le Roy Sargent, St. Petersburg, Fla.; Abel I. Smith, 120 Broadway, New York City; Louis H. Strouse, Samuel Falk and Frank C. Fisher, Trustees in bankruptcy of Metropolitan Finance Corporation, 9 East 40th Street, New York City. *Harris Corporation with the following as Trustees in dissolution of Harvey Fisk & Sons (1921) now dissolved: John J. Donovan, 30 Church Street, New York City; Harvey Fisk, 34 Pine Street, New York City; Wilfred Jessup, Connersville, Ind.; Henry W. Peacock, Jr., 34 Pine Street, New York City; Joseph M. Shellabarger, 30 Church Street, New York City. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) DOUGLAS H. COOKE, Business Manager.

Sworn to and subscribed before me this 8th day of April 1924.

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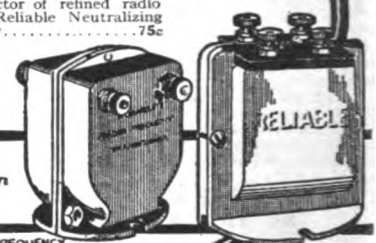

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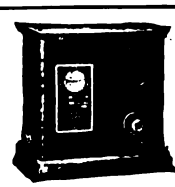

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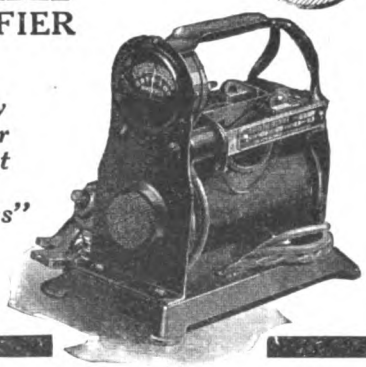

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PERFECT for every CIRCUIT
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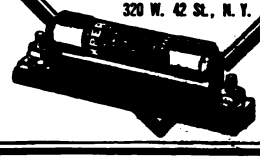

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For UV199 and WD11 tubes

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No deterioration when idle

At your dealer's or postpaid for $1.35 each. Renewals 50 cents each. Write for circular

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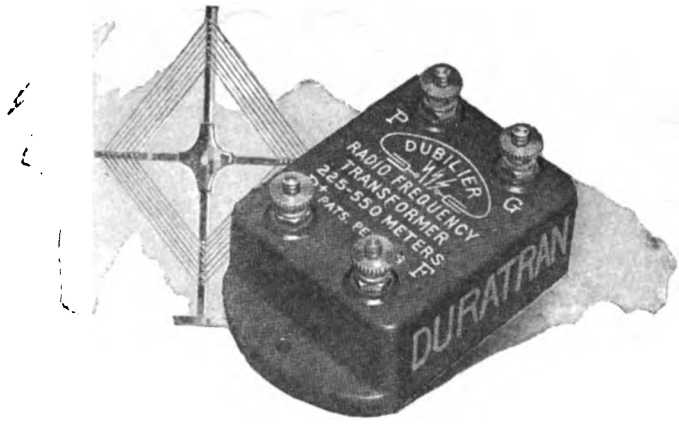

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Less static is picked up with the indoor loop, especially the directional loop, than with an antenna.

Combine the indoor loop with the Dubilier Duratran radio-frequency transformer, and you make DX summer reception perfect.

The Duratran amplifies powerfully and uniformly over the entire band of broadcasting wave lengths. The Duratran dampens the longer static waves and amplifies the waves sent from the broadcasting station. Broadcast music and speech predominate over static.

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Ask your dealer for free blueprints of Duratran hook-ups. If he has none write for them to us and give us his name.

The indoor-loop and one or two stages of Duratran radio-frequency amplification—the combination can't be beaten for summer reception.

Dubilier Condenser and Radio Corporation

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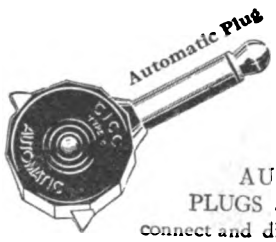

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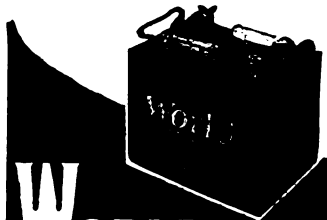
Every CICO PRODUCT is packed in a distinctive GREEN BOX and unqualifiedly guaranteed against all defects.

Consolidated Instrument Co. of America, Inc., 41 East 42nd St., New York



WORLD BATTERY
Saves You 50%

Famous Guaranteed Quality and Service—Backed by Years of Successful Manufacture and Thousands of Satisfied Users.

Prices That Save and Satisfy

Auto Batteries		Radio Batteries	
6-Volt 11 Plate,	$12.25	6-Volt 60 Amps.	$ 8.50
6-Volt 13 Plate,	14.25	6-Volt 80 Amps.	10.00
12-Volt 7 Plate,	17.00	6-Volt 100 Amps.	12.50
		6-Volt 120 Amps.	14.50
		6-Volt 140 Amps.	16.00

Special 2-Volt Storage Battery for W.D.11 and 12 tubes. Will run 200 hours on one charge. Rechargeable. **$8.00.** Special 4-Volt Storage Battery for U.V.199 tubes. Same features as 2 Volt. **$8.00.**
Shipment express C.O.D. subject to examination. 5% Discount for cash in full with order.

2-Yr. Guarantee Bond in Writing With Each World Storage Battery
proves satisfactory World performance. Mail this ad with your name and address and we will ship battery day order is received; and give you a 45-Volt "B" Battery and Hydrometer **Free** with each battery purchased. Write **today.**

World Battery Company
Dept. 3, 1219 S. Wabash Ave.
CHICAGO, ILL.

FREE
45 [illegible] BATTERY
and
HYDROMETER

MU-RAD
RECEIVERS
The Ultimate in Radio Reception

Make $100 Weekly In Spare Time

Sell what the public wants—long distance receiving sets. Two sales weekly pays $100 profit. No big investment, no canvassing. Sharpe of Colorado made $955 in one month. Representatives wanted at once. This plan is sweeping the country—write today before your county is gone.

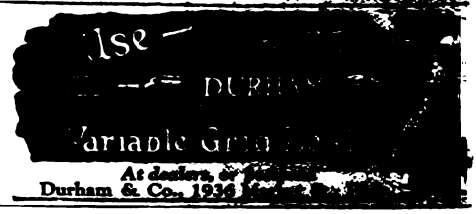
OZARKA, 855 Washington Blvd., CHICAGO

WALNART

Booklet free!

Tube Sockets—Inductance Switches—Lettered Binding Posts—Dials—Variable Condensers, plain and Vernier—Variable Grid Resistance, Vernier Adjusters, etc. Ask your dealer.

WALNART ELECTRIC MFG. CO., CHICAGO



At dealers, or Durham & Co., 1934

Please refer to POPULAR RADIO *when answering advertisements.*

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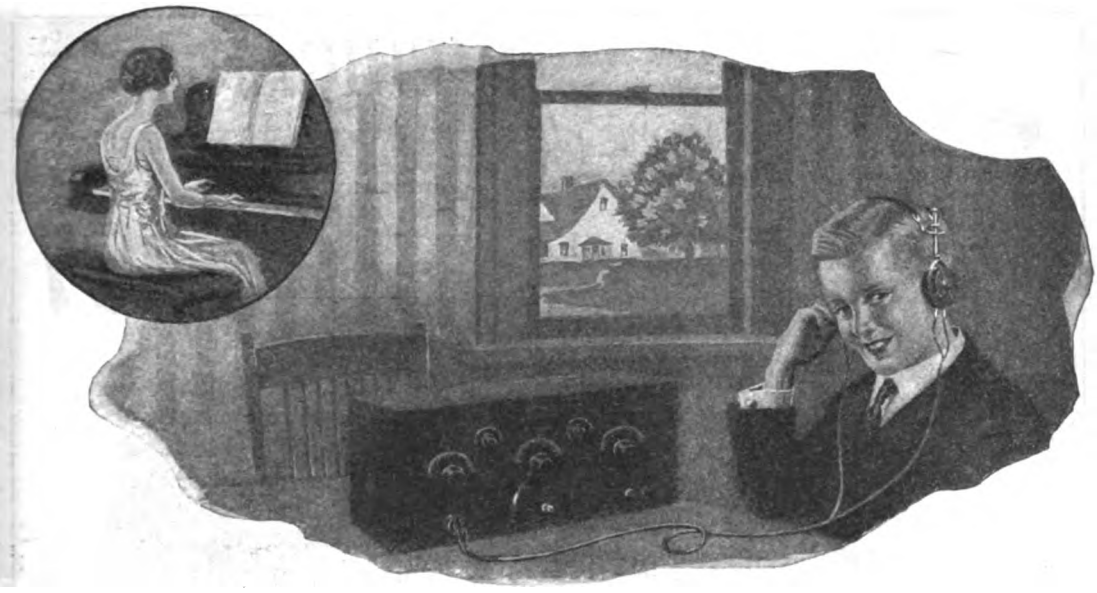
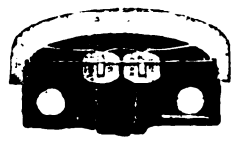


You hear each note *as if you were right there*

NO MATTER how fine a receiving set you have —it is no better than the headphones you use. Connect a pair of Murdocks to your receiver —and tune-in on local or distant stations. It's the real thing. Voices and music come in mellow and true — clearly and with wonderful volume. Just as if you were in the same room.

Murdock Radio Phones represent the highest acoustical efficiency. Particular attention is given to the proper seating and clamping of the diaphragms. This prevents distortion. The sensitive diaphragms translate radio signals into the natural sounds of voice and music.

Their extremely light weight enables the user to wear Murdocks for hours without discomfort. The head-band is of new design, flat and yielding, and will not bind the head. Ear caps are especially designed to exclude outside noises. There are no screws on the head-band or adjusting rods.



Built, not assembled

Murdocks are made in a single unit, of superior moulded insulation. Each part is fitted by one process into its proper place. They are moulded together — assuring firmness, strength and durability. And they can't get out of adjustment

Murdock Radio Phones are the result of 20 years of research and effort to make a high grade head 'phone that sells at a moderate price. Over 1,000,000 Murdocks are in use today. Quantity production has enabled us to standardize our quality and price — so that when you buy a Murdock you are sure of getting the best possible 'phone value. Buy a Murdock today and test it out. They are fully guaranteed.

Murdock 'Phones and Plugs at your nearest dealer

WM. J. MURDOCK COMPANY 374 Washington Avenue, Chelsea, Mass.

Branch Offices: **Chicago and San Francisco**

MURDOCK RADIO PHONES

Standard since 1904

—MAIL COUPON FOR FREE BOOKLET—

Wm. J. Murdock Co.
374 Washington Ave., Chelsea, Mass.

Gentlemen: Please send me, without obligation, your free booklet, "The Ears of Radio," which explains the importance of radio 'phones to efficient radio reception.

Name .....

Street .....

City ..... *State* .....

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MICHIGAN

Just the set to take on vacation—camping or touring trip. Space in back for batteries, everything self contained.

Slip one in the car and take it with you this summer.

Michigan Detector and Two-Stage Amplifier. Brings in far-off stations on any loud speaker. Not excelled by sets at twice the price. Model M 12,

$57

Licensed under U. S. Pat. 1,113,-149 letter pending 807,-388.

DISTANCE — VOLUME — SELECTIVITY

Watch for our special announcement in July issue Write for illustrated folder

MICHIGAN RADIO CORPORATION, 34 Ottawa St., Grand Rapids, Michigan

Use HOMMEL SERVICE *to build your radio business*

By aligning yourself with the Hommel Organization you have access to ample stocks of the leading lines of radio equipment at all times, and can serve your customers promptly without the necessity of tying up your own working capital.

Write for Hommel's Illustrated Encyclopedia #246. P

LUDWIG HOMMEL & COMPANY
WHOLESALE JOBBERS EXCLUSIVELY
530 Fernando Street
PITTSBURGH, PENNA.

FREE TO READERS

Many POPULAR RADIO readers have asked how they might secure a copy of "How to Build Your Radio Receiver," described on page 80 of the advertising section. Readers who are not subscribers should take advantage of the present offer and secure it *free* with an annual subscription at the regular rate of $3.00. Subscribers whose term expires during 1924 should place a twelve months' renewal at this time and secure the Handbook *free*.

But until July 1, 1924, we will send anyone a free copy of the Handbook who forwards $6.00 in payment for two *new* annual subscriptions for POPULAR RADIO with Handbook free.

Each new subscriber receives "How to Build Your Radio Receiver" with his annual subscription and you get a copy free for sending these two orders.

Dept. 611
POPULAR RADIO
627 West 43d St. New York City

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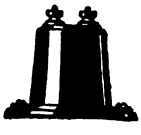
Haynes-Griffin

RADIO SERVICE, Inc. **41 West 43rd St., N. Y. City**

A. J. HAYNES

Designer of the Haynes Set, and special parts for the Super-Heterodyne

Haynes-Griffin Transformer

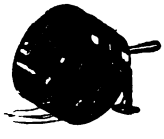


$4.25

An efficient intermediate wave radio frequency transformer giving a minimum of audio frequency amplification. Uniformly tuned to a limited wave length range.

Indispensable to those who went the best results from the super-heterodyne.

Special Oscillator Coupler



$3.50

Specially designed by Mr. Haynes for use in the super-heterodyne. Essential for the proper operation of this best-of-all circuits.

The Simplified Super-Heterodyne

IN September, October, November and December, "Popular Radio," Laurence M. Cockaday, Technical Editor, describes the construction and operation of the new, simplified super-heterodyne.

These articles give the average experimenter his first opportunity to realize all the wonderful advantages of the super-heterodyne—"The Rolls-Royce of Radio"—"The Master DX Receiver." In selectivity and long-distance range the super-heterodyne far surpasses anything known today. In quality of reproduction it reigns supreme.

The experiments and research of A. J. Haynes have led to the development of this simplified design consisting of the Haynes Set, a Separate Oscillator, and an Intermediate Radio Frequency Amplifier. In addition, a two-stage audio amplifier may be used, if desired.

Experimenters who have built the famous Haynes Set need make no changes in their original assembly. They have simply to add the other two or three units.

Converted to a Loop Receiver

In the June 1924 "Popular Radio," A. J. Haynes tells how to convert the simplified Super-Heterodyne to a loop receiver.

This can be done at small cost, with few changes in the original design.

Send for FREE LEAFLETS and Price List of Parts

Leaflets describing the simplified super-heterodyne, including complete data for converting it to a loop receiver, mailed anywhere upon receipt of 4c in stamps to cover cost of mailing.

Price list of parts also included.

Three-Unit Simplified Super-Heterodyne

HAYNES-GRIFFIN RADIO SERVICE, Inc. **41 WEST 43rd STREET NEW YORK CITY**

Mail Order Dept., 145 West 45th St., New York City

New York's Largest Radio Store

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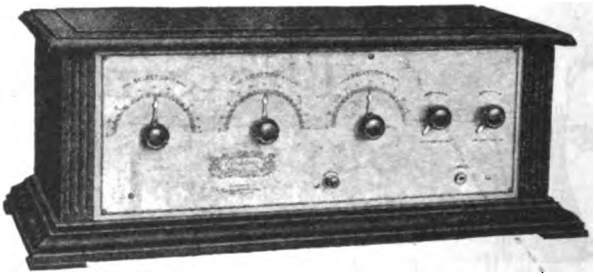
ANOTHER CLEARTONE ACHIEVEMENT

The Approved

SUPER CLEAR-O-DYNE

Model 80
$120.00

Console
Model 82
$190.00



—5 Tubes
—Selective
—Long Range
—Logable
—Volume

The new 5-tube Goldcrest Super Clear-O-Dyne model 80 is the latest achievement of Cleartone engineers, and the last word in Radio reception. 5-tubes give long range reception, selectivity, loud speaker volume and perfect control, as the new Super Clear-O-Dyne can be neutralised by anyone in a moment to suit any Antenna conditions.
The Model 80 logs accurately and operates on all types of tubes. The beautifully etched gold finish panels and the distinctive solid mahogany cabinets combine to give you a receiving set which is a real source of education and a great pleasure to the entire family. Even at this time of the year, long distance records are being established. Write to us today for free illustrated circulars showing our entire line of Receivers and beautiful cabinet models.

DEALERS AND JOBBERS. Here is your opportunity. We have an interesting proposition for you, which is a real business builder. A line to us will bring complete information. DO IT NOW!

Model 60	$60.00	Clear-O-Dyne Model 70	$75.00
Model 61	75.00	Clear-O-Dyne Model 71	90.00
Model 62	120.00	Clear-O-Dyne Model 72	135.00

The Cleartone Radio Company, :: :: Cincinnati, Ohio

Blueprints Free—Take Your Choice

Improved Cockaday 4-Circuit Tuner
Non-regenerative Tuned Radio-frequency Receiver
Audio-frequency Distortionless Amplifier

We have prepared sets of Blueprints for the "Improved" Cockaday 4-Circuit Tuner, the Non-regenerative Tuned Radio-frequency Receiver and an Audio-frequency Amplifier. Each set consists of three Blueprints:

a Panel Pattern (actual size)
b Instrument Layout (actual size)
c Picture Diagram (all parts actual size) showing all wiring connections

The "Improved" Cockaday 4-Circuit Tuner described in the January issue of POPULAR RADIO, needs no special description or recommendation. Automatic tuning, practically unlimited distance range, maximum volume of sound and excellent reproduction without interference are outstanding features to which thousands of satisfied builders will attest.

The Non-regenerative Tuned Radio-frequency Receiver described in the April issue utilizes a circuit embodying the Neutrodyne principle. And the enthusiastic letters indicate that its claims for ease of control, distance range and clarity of reception are justified.

An Audio-frequency Amplifier that does not distort was described in the May issue.

Any of these sets of Blueprints will be mailed promptly, absolutely free of charge, if you will send us one annual subscription for POPULAR RADIO, accompanied by a remittance of $3, the regular subscription price. The subscription may be new or renewal; your own or a friend's—and for a limited time will include FREE a copy of "How to Build your Radio Receiver" described on page 80.

Two sets of Blueprints for 2 annual subscriptions with remittance of $6; all three sets of Blueprints for 3 annual subscriptions and remittance of $9.

You know how helpful, interesting and practical POPULAR RADIO is. You fully appreciate that at $3.00 a year it is a real bargain. Consequently you should find it easy to convince one, two or three friends of the unusual value offered when "How to Build Your Radio Receiver" is included free with their twelve month order at the regular price of the magazine alone. So get busy today and see if you can't mail the coupon for your Blueprints tomorrow.

POPULAR RADIO, 627 West 43d St., New York City, Dept. 63

Enclosed is my remittance of $.....covering.....annual subscriptions for POPULAR RADIO (additional names on sheet attached).

Send me the set of 3 Blueprints checked.

Name.....

Address.....

City.....State.....

☐ "Improved" Cockaday 4-Circuit Tuner, ☐ Non-regenerative Tuned Radio-frequency Receiver, ☐ Audio-frequency Amplifier.

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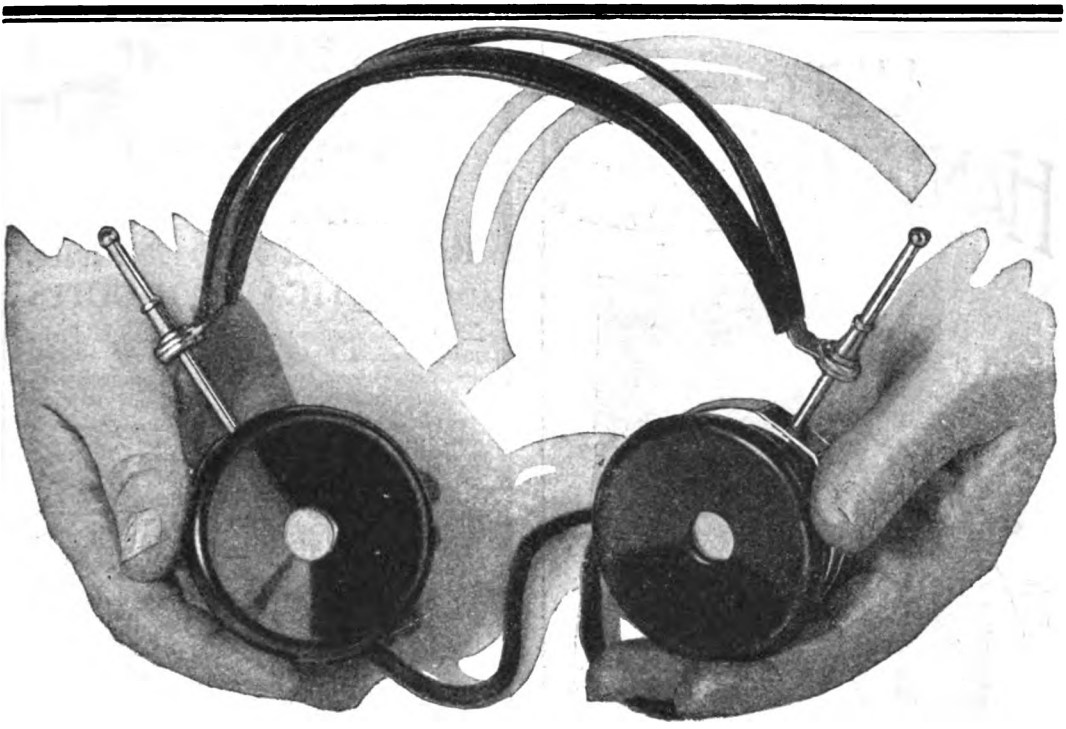

The Phones with the New Idea

N & K Head Sets mark a new era in radio reproduction—an era of *clearness* and *naturalness*. Designed especially for the reception of *musical tones*, they record the entire range of the human voice and of musical instruments with extreme clearness and freedom from distortion. This is due to mechanical design different from that of any head set produced in America. The *extremely careful quality of workmanship* used is almost impossible to obtain in this country.

Sold on a comparison basis

If, when you use N & K Phones on your own radio set, you do not find that they reproduce all the tones more clearly and naturally than any set you ever used before, and if they do not fit more comfortably, the store where you bought them will refund your money, promptly and cheerfully. We protect dealers and replace any returned phones.

N & K Head Set, Model D, 4000 ohms, has extra large diaphragms and ear caps, insuring better reproduction, better comfort and the exclusion of outside sounds. Sanitary, leather-covered head bands. Six feet of stout cord. Retail price $8.50. Write for "*The Phones the Fans Are Talking About*," interesting new descriptive folder.

TH. GOLDSCHMIDT CORPORATION
Dept. P6, 15 William St., NEW YORK
Exclusive Distributors for U. S., Canada and Mexico

N & K

Imported

PHONES

DEALERS: N & K Phones provide the high spot in the radio stocks of dealers all over America. Backed by advertising and strong sales co-operation, they are proving attractive profit-makers. Packed in cartons of ten, with display material.

N&K "KING OF THE AIR" TRADE MARK

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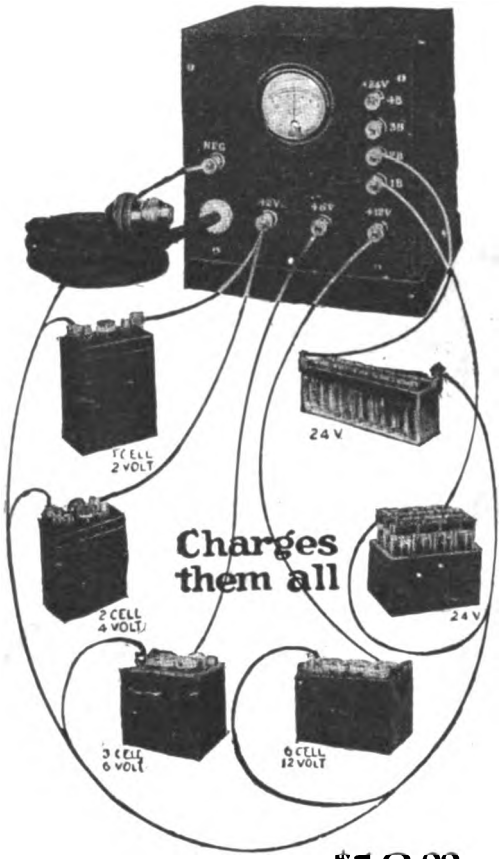
ULTRA HANDY CHARGER



ULTRA MODEL $18.00

Note

"Handy Charger" Features

No bulbs to break.
No acids to spill.
No fast-wearing parts.
No auxiliaries necessary.
No sticking contacts.
No wood used—Fireproof.

Beautifully finished Case — automatic in operation. Costs less than 1 cent per hour to run. Ask your dealer. Illustrated descriptive folder on request. Write us.

INTERSTATE ELECTRIC CO.
of St. Louis, Mo. 4015 Laclede Ave.

FRESHMAN
NOISELESS
TESTED MICA CONDENSER
MFG. BY
CHAS. FRESHMAN CO. Inc.
NEW YORK CITY

ACCURATELY RATED CONDENSERS *for* CRITICAL CIRCUITS

Through the accuracy and dependability of Freshman Noiseless Tested Mica Condensers, hookups and circuits have been perfected which have completely revolutionized the art of radio reception.

The Freshman is so designed that constant equal pressure is exerted on the condenser plates over the entire area. They are the only condensers that have this construction and therefore the only ones that avoid noises, due to variable pressure on the plates.

All capacities—from 35c up.

Ask your dealer for prices on all capacities of Freshman Fixed Condensers. He has them in stock.

"Modern The Long Distance Sets Get Freshmans!"

Write for circular M-1, giving complete information and prices on our entire line.

Chas. Freshman Co. Inc.
Radio Condenser Products
106 Seventh Avenue, New York

NA-ALD

De Luxe Dials

The artistic qualities of Na-ald De Luxe dials distinguish these dials as truly beautiful. They add to the appearance of any set in which they are used.

Na-ald Dials have a high gloss finish. They are moulded of genuine Bakelite and have patented construction. Dials are matched and made in 2", 3", and 3¼" sizes.

Alden Manufacturing Company
Largest makers of Radio sockets and dials in the world
Dept. C 82 Willow St.
Springfield, Mass.

No. 3003—4
3 Inch
35c, 3 for $1.00

SOLDER WITH INSULATION

At Least 1,000 Miles More Distance

is the usual reward if you can solder without impairing the insulation of your set.

If you are building a radio-frequency amplifier you should read our free booklet:

"HOW TO SOLDER RADIO SETS"

Write for it

THE VALLEY FORGE CHEMICAL CO., Valley Forge, Pa.

Radio HARTMAN Products

HARTMAN ELECTRIC CO.
MANSFIELD, OHIO.

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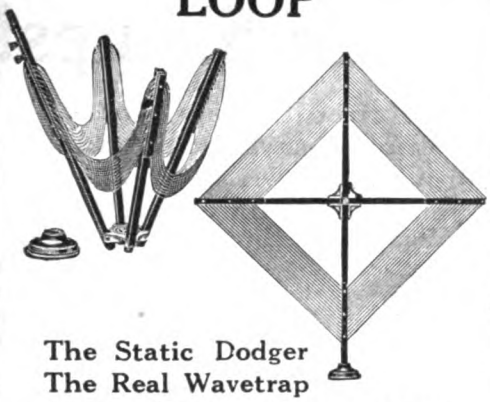
MARION FOLDING LOOP



The Static Dodger
The Real Wavetrap
Opens Instantly
Absolutely Vertical
Unusually Sensitive

$7.00

For Jobbers' territory still open inquire of
C. M. HUNT, 50 Church St., New York, N. Y.

Mfrd. by MARION ELECTRICAL MFG. CO.
24 CLIFF ST. JERSEY CITY, N. J.

"Stand by One Moment, Please!"

YOU lost that station because you didn't have enough room on your vernier attachment. You would have got it with a "UNITY" because the *whole* UNITY Rheostat is one *continuous* vernier.

Efficient, compact, and guaranteed to give satisfaction. ALL RESISTANCES $2.00

UNITY
Vernier Rheostat
"Hear a Set that Uses One!"

UNITY MFG. CO., 224 N. Halsted St., CHICAGO
NEW YORK OFFICE: 50 Church Street

S. HAMMER RADIO CO.
303 Atkins Ave. Brooklyn, New York

New Cockaday Distortionless Amplifier
Complete Parts Exactly as Specified by Mr. Cockaday

	List Price		List Price
4 Na-ald Sockets	$4.00	1 Pr. Como Dup. P. P.	$12.50
2 Marco Jacks	2.00	1 Amertran, 5 to 1	7.00
2 Amsco 20 ohm Rheostats	2.50	1 Dubilier .00025	.45
1 Bradleyohm No. 25	2.00	6 Dubilier .005 Cond.	3.90
1 Bradleyleak	1.85	10 Eby Binding Posts	2.00
		1 Panel 7x12	2.25

List Price, $40, for above complete parts. OUR PRICE $28.50

The above parts may be bought separately. Write for our catalogue

Orders over $5.00 Shipped Prepaid, Money Orders or C. O. D. One-third must accompany all C. O. D. orders. Not insured unless insurance charges included.

Supremacy Proven by Every Test!

The filament kontrol of infinite adjustment

FIL-KO-STAT

The SCIENTIFICALLY CORRECT RADIO RHEOSTAT for All Tubes!!

Take a Fan's Word For FIL-KO-STAT

"It cuts out all noises experienced when a wire rheostat is used. I have heard KHJ Los Angeles three times." Eugene Markley, Crellin, Md.

Get This FREE Booklet Radio Handbook!

"Improved Radio Reception Through Scientific Tube Tuning."

Tells you what brings in DX Stations you never heard before. How to make tubes last long. How to control maximum regeneration yet produce minimum re-radiation, etc. Published by

DX INSTRUMENT CO.
Dept. P. R. 6-24
Harrisburg, Pa.

Write for your FREE copy Today

Unconditionally Guaranteed

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Your Choice!
—for Only 35 Cents in Stamps!

Hundreds of reliable hook-ups and circuit diagrams—practical hints and handy knacks—money-saving tips and pointers on how to make and improve your own sets. Take your pick of all this authoritative information on radio!

PERHAPS you haven't realized what a tremendous amount of information is available in the back issues of POPULAR RADIO. Since the first number was published, May, 1922, literally hundreds of requests have come to us for these valuable back issues of POPULAR RADIO which contain so many practical hints and worth-while suggestions.

There are still a few copies left of many of these back issues. *While they last* you can take your pick of them at only 35 cents each, to cover cost and mailing. Here's your opportunity to complete your files of POPULAR RADIO and to add to your store of information on just the subjects which interest you.

Glance over this partial list of contents of each issue. Then tell us which ones you want, enclosing stamps, check or money order to cover your requirements. Our stock is getting very low, so don't delay taking advantage of this offer!

May, 1922

—Harnessing waves to wire.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How electricity is generated.
—Tones that do and don't broadcast.
—How to make a simple tube Receiving Set.

July, 1922

—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—How to make a variable condenser.

September, 1922

—How to build the Armstrong Circuit Receiver.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922

—How to make a spider-web tuner.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922

—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—The most popular transmitting aerial.
—How to make a novel variocoupler.

December, 1922 (Out of stock.)

January, 1923 (Out of stock.)

(A Reprint of Mr. Cockaday's article describing the DX Regenerative Receiver may be had for 25 cents.)

February, 1923 (Out of stock.)

March, 1923 (Out of stock.)

April, 1923 (Out of stock.)

May, 1923 (Out of stock.)

(A full description, however, of Mr. Cockaday's original 4-Circuit Tuner will be found in POPULAR RADIO'S handbook, "How to Build Your Radio Receiver," advertised on pages 70 and 80.)

June, 1923

—How the microphone transmitter works.
—How to build a good single tube receiver.
—How to make a crystal detector stand.

July, 1923

—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

August, 1923 (Out of stock.)

(A full description, however, of the Tuned Radio Frequency Receiver will be found in POPULAR RADIO'S handbook, "How to Build Your Radio Receiver," advertised on pages 70 and 80.)

September, 1923

—How to get a radio license.
—How weak signals are regenerated.
—How to make a battery charging rectifier.
—How to build the Haynes DX receiver.

October, 1923

—Practical hints for Coil Calculations.
—How to make a Two-stage Audio-frequency Amplifier.
—Ten good rules for Broadcast Listeners.
—How to make a simple Honeycomb Receiver.

November, 1923

—The 100 Best Hook-ups (Part 1).
—Receiving without Antennas.
—How to build the New Regenerative Super-heterodyne Receiver (Part 1).
—How to build a combination Short and Long-wave Receiver.

December, 1923

—How to Select your Radio Parts.
—The 100 Best Hook-Ups (Part 2).
—How to Read a Diagram (Part 1).
—How to Build an efficient Crystal Receiver.
—How to Build the Super-heterodyne Receiver (Part 2).

January, 1924 (Out of stock.)

February, 1924

—How to add "Push and Pull" amplification to the original 3 tube Cockaday 4-Circuit tuner.
—The original 4-Circuit Tuner as a Portable Set with Loop.
—The 100 Best Hook-ups (Part 4).
—How to build a 3-tube Reflex. Receiver (Part 1).

March, 1924

—Hoffman Transformer Measurement Chart.
—The 100 Best Hook-ups (Part 5).
—How to Build an Amateur Transmitter.
—A 3-tube Reflex Receiver (Part 2).

April, 1924

—How to Build a Simplified Neutrodyne Receiver.
—The 100 Best Hook-ups (Part 6).
—How NOT to Tune the Single Circuit Receiver.
—A Novel Substitute for "B" Batteries.

May, 1924

—A Compact Radio Kit for a Spring Hike.
—How to Get the Maximum Radio-frequency Amplification.
—Getting Static's Autograph
—100 Best Hook-ups (Part 6).
—A measurement Chart for Use in Designing a Rheostat.
—Where Interference Comes In.
—How to Make an Audio-frequency Amplifier that Does Not Distort.

POPULAR RADIO, INC.

627 West 43d Street **Dept. 68** **New York City**

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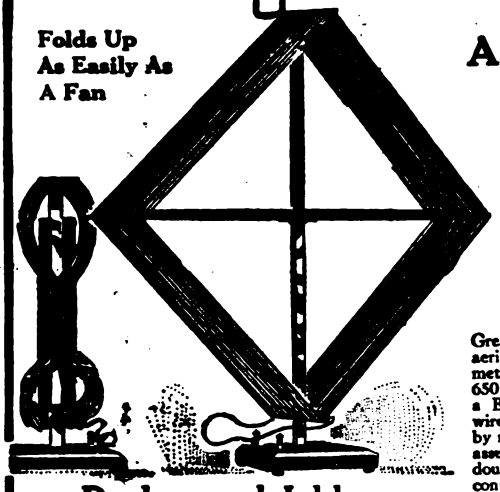
Collapsible Loop Aerial



Folds Up As Easily As A Fan

Assures Clear, Uninterrupted Reception

The supreme aerial of them all. A highly selective, static-free aerial that collapses with the greatest ease. Elegantly made and a credit to the finest home. Is simple, allows no leakage, is not magnetic. No lightning risk and no interference from the landlord. When folded, it fits into a suitcase.

Ideal for Vacation, Camp or Home

Great for vacationists and tourists. No climbing trees or poles erecting aerial. Just set up anywhere and "listen in." Has a natural period of 145 meters. Will respond to waves up to 650 meters. On the end of each arm is a Bakelite insulator thru which the wire is always held at a tension, thereby making your set more selective and assures better reception. Wire is double insulated with green silk and consists of 10 separate strands. The frame is finished in mahogany and the tubing is of brass, exquisitely nickeled.

$12.50 Postpaid

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— for —

Cockaday distortionless amplifier Bradley ohm No. 25	2.00
Amertran transformers 5 to 1 Ratio	7.00
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Parts for Craig coupler and radio frequency transformer	3.25
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Complete set genuine Cockaday coils ..each	5.50
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All parts are exactly as those used by designers in the original hook-ups

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$5 EACH Complete with clips ready to mount on your set; no sockets or extra equipment required.

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E. B. Myers Co. Ltd. *Radio Vacuum Tubes*

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IN constructing any radio apparatus you will find POPULAR RADIO BLUEPRINTS time saving, money saving and labor saving—three outstanding features that will appeal to you.

EACH set consists of three prints; (A) Panel Pattern; (B) Instrument Layout; (C) Wiring Diagram.

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This blueprint is the exact size of the actual set. So accurate that you need merely lay it on your panel and drill as indicated. You can readily appreciate the convenience of this Blueprint. No scaling to do, no danger of ruining the panel through faulty calculation.

Instrument Layout.

Again you have an actual size print of each instrument and binding post and its exact location both on the panel and within the cabinet. Even the cabinet structure is clearly shown.

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The unusual feature of this Blueprint is that it is a **full size picture diagram** of the finished set. Each instrument or other part appears exact size and the wires are so clearly traced from one contact to another that you can connect all terminals accurately without even knowing how to read a hook-up diagram.

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At the present time three sets of Blueprints are available and have been priced at the very low figure of $1.10 per set, postpaid. Each set consists of three Blueprints and we cannot break a set to supply single prints.

"Improved" Cockaday 4-Circuit Tuner was described in the January, 1924, issue of POPULAR RADIO. It is a simplified regenerative set that can be built with about $95.00 worth of parts. It provides for automatic tuning, practically unlimited distance range, maximum volume of sound, excellent reproduction and no interference.

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For convenience use the coupon below in ordering sets of Blueprints. If you desire any of the descriptive articles mentioned above, refer to page 76 in the advertising section of this issue.

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- ☐ **"Improved" Cockaday 4-Circuit Tuner.**
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Get results you never dreamed of by putting the famous ROLL-O Long-Distance Crystal on your set. Complete satisfaction guaranteed with any type of crystal set. Stations 800 miles distant received regularly, and even longer distances are common. H. J. Hallam, 5 Koenig Ave., Cincinnati, got 11 stations the same night. P. H. Reynolds, 6253 Norwood Park Ave., Chicago, says he uses a horn and can hear plainly ten feet away. W. E. Teklenberg, Union Central Bldg., Cincinnati, says ROLL-O Crystals beat anything on the market. He got Springfield, Mass., Hastings, Neb., Schenectady, and Pittsburgh the first night he tried ROLL-O Crystals. Other enthusiastic users have sent us unsolicited reports of the unequaled pleasure these crystals have given them. Hundreds have thrown away cheap, inferior crystals to use the ROLL-O exclusively.

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Two ROLL-O-Long-Distance Crystals, two special catwhiskers worth 25c our special instructions and hookups worth 50c—all for only $1. Crystals alone 50c each. Money back without question if not satisfactory. Send check or money order to:

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W.D. 11 or 12
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All tubes guaranteed to do the work

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200 BROADWAY, NEW YORK CITY, N. Y.
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A-C DAYTON

In the August Popular Radio, we will announce the new A-C Dayton XL-5 Receiver, licensed, approved and guaranteed by the Polydyne Corporation of N. Y.

Circular describing this wonderful set mailed on request

THE A-C ELECTRICAL MFG. CO.
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Makers of Electrical Devices for over 20 Years

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THE greatest book on Radio ever written. Price only $1. Filled with sound, practical, tested information for every radio fan, from beginner to hard-boiled owl. Written, compiled and edited by radio experts of national reputation.

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514 PAGES
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Every page tells you something useful. And there are 514 pages! More than 150 illustrations and diagrams! Note this partial list of contents:

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—How to build the 5-Tube "Improved" Cockaday 4-Circuit Tuner.

—How to build the Regenerative Superheterodyne Receiver.

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—How to read a Diagram.

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—Ten good Rules for Broadcast Listeners.

—Practical Pointers for Getting Best Results.

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POPULAR RADIO'S HANDBOOK is too valuable to give away. Its tremendous popularity has convinced us of this. So as soon as the Second Edition is gone no more will be offered on the present terms.

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"How to Build Your Radio Receiver" gives complete specifications for the construction of *seven* separate and distinct receiving sets—covering the most remarkable range and variety of circuits, from the most modern simple crystal set to the famous Super-heterodyne.

All working details are given—the list of parts required and their approximate cost; complete hook-ups and circuit diagrams and ***how to read them;*** illustrations making all points clear, and simple instructions on how to assemble, mount, wire and operate each set.

Ready Reference Guide

In this new book edited by Mr. Banning and Mr. Cockaday, you will also find scores of valuable suggestions about aerials, how to select your parts, how to install your set, tips on tuning and how to learn the code.

In all, a book you will not want to be without—one that will be worth many dollars to you. Yet, if you act at once, it will cost you not a penny. We will send you a copy of this valuable handbook absolutely free with a year's subscription to POPULAR RADIO.

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THE universal verdict acclaims "How to Build Your Radio Receiver" as the outstanding radio contribution of the year. The purpose of the editors was to provide a dependable working guide for the construction and operation of receiving sets that would enable beginner or expert alike to build a set that would exceed expectations in the final results. Their choice included seven representative circuits that in laboratory tests had proved most nearly ideal from the viewpoint of selectivity, tone, volume, distance, simplicity of construction, ease in tuning, reliability and general all-around satisfaction. That the editors have achieved their aim is evident from the large number of letters received by us daily.

You will find sets employing both crystal and vacuum tube detection, with regenerative amplification, audio-frequency amplification, "push and pull" power amplification, radio-frequency, *compensated* radio-frequency and *intermediate* wave radio-frequency amplification.

You have your choice of crystal, one-tube, three-tube, five-tube, six-tube or eight-tube sets—as broad a selection as could be desired, all clearly illustrated, diagrammed and described in the simplest possible terms.

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1 7x26 Baseboard
3 Neutroformers
2 Neutrodons
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2 Jefferson Transformers
2 Filament Control Jacks
1 Cut-Hammer Battery Switch
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1 .00025 Dubilier Condenser
1 2Meg. Leak
2 .006 Mica Condensers
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When this set is hooked up you will be entertained by broadcasting stations thousands of miles away. You will enjoy a revelation of selectivity, volume, distance and clarity. With the dial readings of a station recorded, it can always be tuned in again to the same settings, maintaining at the same time loud-speaking intensity and clarity of natural reproduction. Included in the set is drilled panel, ready for mounting and wiring. A FADA book FREE.

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This is the set that Cockaday described as being able to receive over distances of 3,000 miles. You can't build anything better. (Parts are those specified by Cockaday.)

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1	7x24 Baseboard	.75

Blueprints, Wire, etc., with each order.

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Distortionless Amplifier

Complete parts exactly as specified by Mr. Cockaday.

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1	Panel, 7x12	2.25

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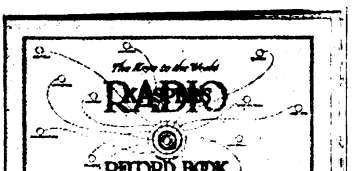

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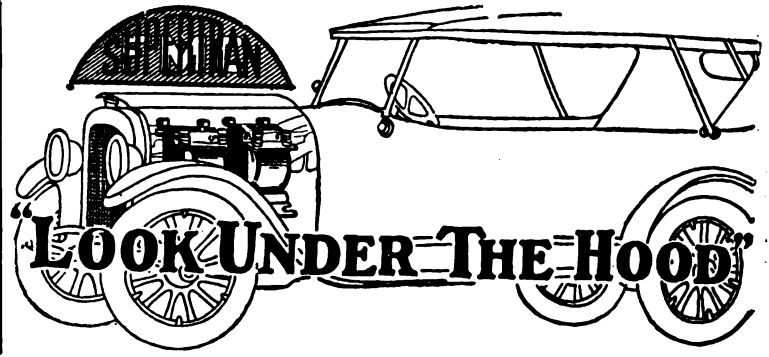
Audio Frequency Transformers

Operate successfully with any amplifying tube.

Preserves natural tone of broadcasting.

Gives greater distance.



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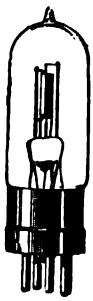

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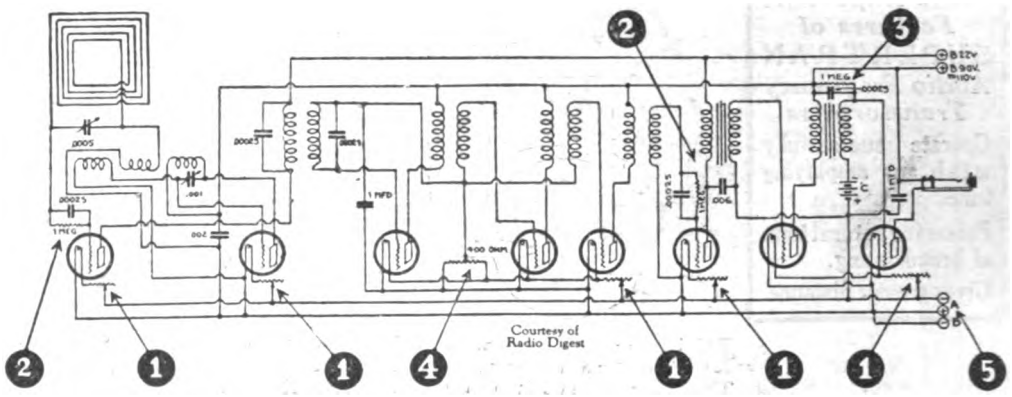

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For all tubes. Provides a stepless, noiseless range of control that simplifies tuning and oscillator control. Holds the record for long range tuning.

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Provides a stepless range of grid leak control from ¼ to 10 megohms. Furnished with or without grid condenser rated at 0.00025 m-f.

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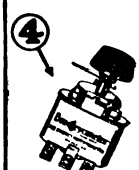

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Made in 200-ohm and 400-ohm ratings for all circuits. Gives a smooth, stepless range of potential control, so essential for super-heterodyne circuits.

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PERFECT BATTERY SWITCH

A compact, enclosed battery switch which requires only one hole in panel to mount it. Nickel-plated and well built. Should be installed in every set to protect tubes against accidental burning. Saves time, tubes, and batteries.

THIS remarkable radio receiver, when properly constructed, is a marvelous hook-up for selective tuning and long range. It is gaining in popularity, everywhere, and is destined, no doubt, to become one of the leading types of receivers among discriminating radio enthusiasts.

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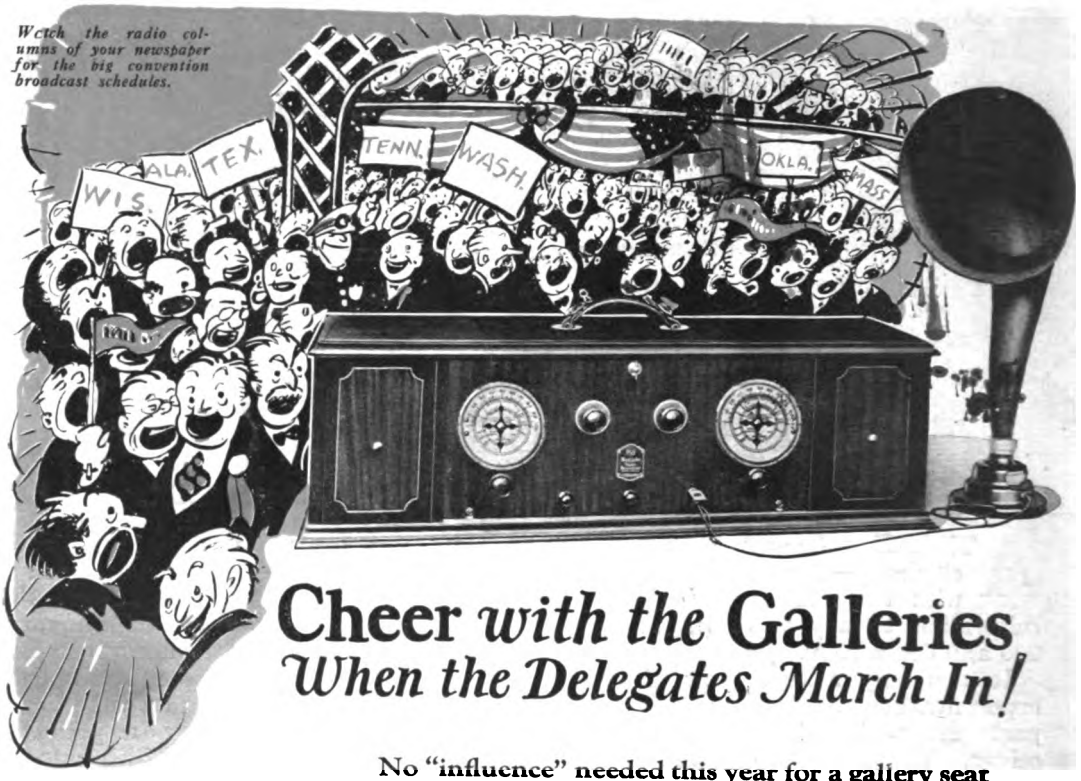

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